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LAKE WAKATIPU, NEW ZEALAND.

BY I. C. RUSSELL.

LAKE Wakatipu is remarkable not only for the grandeur of its scenery, which some travelers assert is equal to that of Switzerland, but also for the many interesting features in its physical geology.

Lake Wakatipu is situated about a hundred miles from the southern end of the South Island of New Zealand, among the picturesque mountains of the Southern Alps. Its æsthetic features we will not attempt to describe; a conception of its varying scenes, some of which are as wild and grand as others are soft and beautiful, can be conveyed only by the brush of the artist; we endeavor merely to tell the story of their origin.

The lake is of a sigmoidal shape, about seventy miles long, and from one to three broad. Its waters, which are very clear and cold, have been sounded to the extraordinary depth of *fourteen hundred feet*. The surface of the lake being about one thousand feet above the sea, its bottom, therefore, is four hundred feet lower than the surface of the ocean. On either side of the lake, and thoughout its whole extent, the mountains rise in a continuous series of very rugged peaks to a height of from five thousand to seven thousand five hundred feet, while Mt. Earnslaw, which forms the head of the valley, attains an elevation of 9165 feet, its top white with perpetual snow, and its sides scored by descending glaciers.

The valley of Lake Wakatipu extends southward beyond the foot of the lake for a distance of fifty or sixty miles, and gradually spreads out into the low, level country which forms the province of Southland. As the physical features of the lower portion of the valley are not essentially different from those of the immediate shores of the lake, we are forced to consider them

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as having a common origin, and being but portions of the same valley, the upper part of which is filled with fourteen hundred feet of water, and the lower portion by an unknown depth of worn and rounded shingle. The rocks in which the valley is formed are, for the most part, clay slates and gold-bearing mica schists, which are very much curved and twisted, and in many places green with chlorite.

When we look for the causes, the working power that has produced these grand results, the mind becomes awestruck by the magnitude of the forces which have formed not only the grand valley, but the very mountains in which it exists.

What pictures pass before us when we follow in rapid review the great changes that have resulted in the formation of these rugged mountains, gray and scored as they are by time. We see the sediments which for ages have slowly accumulated at the bottom of the sea, and formed the mud and ooze of ancient oceans, by the action of heat and great pressure hardened and crystallized into rock, and then slowly upheaved by the mysterious volcanic forces into lofty mountain chains whose snowy peaks gleam above the clouds, only to be slowly removed, to have great valleys opened in their sides, and their most solid rocks worn away and carried down particle by particle to be spread out once more at the bottom of the sea. If we consider these changes, grand as they are, as but a single circle in the great cycle of geological time, we can appreciate to some extent the wonders of the history that is written on the rocks. It is only to the last chapter in this history — the formation of the valley — that we would ask your attention.

Valleys may be considered as owing their origin, primarily, to one of three causes: (1.) They are formed by a folding of the rocks, thus forming depressions, the sides of which slope inwards towards the axis, hence designated as *synclinal valleys*. Examples of valleys formed in this way are to be met with wherever stratified rocks have been upheaved, as in the Sierra Nevada, Rocky, and Alleghany Mountains. (2.) Valleys are sometimes formed by the fracturing of the earth's crust by volcanic forces. Valleys of this kind are seldom seen, being confined to regions of great volcanic disturbance. (3.) The kinds of valleys above noticed are usually greatly modified by denudation, which is another great agent in their formation. By denudation we understand the wearing away of rocks not only by wind, frost, and rain, but also by the more powerful action of ice and running water, the operation of which we can see everywhere about us.

As the evidence of a synclinal axis is nowhere apparent in the valley of Lake Wakatipu, we are unable to account for its existence by the upheaval of the mountains on either side of it. We are likewise at a loss to find any indication of the rocks having been rent asunder by volcanic forces. The formation of the valley can be referred only to the third cause, that of denudation, or the slow removal by ice and water of the rock that once filled it to a height greater than that of the mountains which now tower above it.

It may seem strange at first sight that such an immense amount of rock — measured by hundreds of cubic miles in the valley of Lake Wakatipu alone — could have been worn down and transported to distant places by the slow action of ice and water. This difficulty would be removed, could our readers stand with us on one of the many lofty mountains which overlook the lake, and see far up at its head, amid many mountains less grand, the snowy summit of Mt. Earnslaw, on whose sides are blue regions of ice; these are the descending glaciers in which lies the secret of the valley's formation. In those streams of ice that flow down from the snow-fields of Mt. Earnslaw, vast and irresistible as they are, we see but the puny remains of a mighty river of ice that once flowed through the whole valley of Lake Wakatipu, the extent of which was limited only by the ocean, which undermined and floated away its extremity in the form of icebergs, in the same manner that they are formed at the present day on the coast of Greenland. It takes but a glance to convince us that this great ice-river was the engraving tool that, aided by storm and frost, cut in the living rock the picture of wonderful grandeur and beauty that is spread out before us.

The glaciers around Mt. Earnslaw are still at work, as they have been for ages, in extending the valley. The streams that are formed by the melting of the ice are all the year turbid with silt, which is the rock that has been ground fine by the glacier, the flour from the mill, which they deposit in the upper end of the lake. In this manner some six or eight miles of the valley has been filled up to a height of a few feet above the usual level of the lake. We have but to extend the forces now in operation on Mt. Earnslaw to the whole valley of Lake Wakatipu, to have an accurate and satisfactory explanation of its formation.

There is another feature of great interest in the history of this valley, first made known by Captain F. W. Hutton, of Dunedin. On the shore of the lake, about twelve miles above Queenstown,

is a limited deposit of tertiary limestone, containing as fossils, *Ostrea Wullerstorfii*, *Cucullæa alta*, *C. Worthingtoni*, *Panopæa plicata*, and many others. The junction of the limestone with the crystalline rocks beneath can be seen but a few feet below the surface of the lake. The limestone being at the present level of the water, the valley must have been eroded to that depth before the limestone was formed. As its deposition took place beneath the waters of the ocean, the valley was at one time an arm of the sea, and was afterwards upheaved to its present elevation or higher, and the wearing down of the valley continued. We have, therefore, as the sequence of events that resulted in the formation of Lake Wakatipu, the following: —

(1.) The Southern Alps forming a sloping table-land, the highest remaining point of which is Mt. Cook, 13,200 feet above the sea; on this high table-land were deposited immense amounts of ice and snow, brought by the warm, moist winds from the ocean, which formed the glaciers that flowed off in various directions towards the sea. One of these ancient rivers of ice had its source in the region about Mt. Earnslaw, — which, however, was then greatly different from its present form — and flowed over what is now the valley of Lake Wakatipu. This old-time glacier continued its slow motion towards the sea for unknown ages, until it had ground out the solid rock to a depth of five or six thousand feet in vertical thickness, and for over a hundred miles in length.

(2.) The work of this mighty glacier was finally terminated by a sinking of the land, which caused the valley to become an arm of the sea, similar in every respect to the deep, narrow fiords that form such a characteristic feature of the west coast of New Zealand at the present day. What before was an alpine valley filled with hundreds of feet of ice then became the home of huge oysters, and many other forms of marine life, whose remains we now find in the limestone. We know that the sea filled the valley for a long time, since the compact gray limestone that it left behind it was not formed rapidly, as sandstone and conglomerate may be, but the material was first gathered from the waters to form the shells of mollusks and foraminifera, or the hard parts of corals, crinoids, etc., and then these worn down to a fine detritus by the waves and spread out as a calcareous sediment, before the hardening process of rock-making can commence. Together with the limestone are beds of fine shale and masses of conglomerate, composed of both rounded and angu-

lar pebbles and containing fossil shells (*Crassatella ampla*) These deposits speak of other although minor changes during the time that the waters of the ocean occupied the valley.

(3.) In the third stage the land is again upheaved to the dignity of a mountain chain, whose lofty summits become covered with vast fields of snow and ice, which, seeking an equilibrium, again flow as a glacier down the valley of Lake Wakatipu. This second extension of the ice-stream down the old valley resulted in the removal not only of most of the limestone that had been deposited, but also of fourteen hundred feet of the crystalline rocks beneath. The limestone on the shore of the lake is thus shown to be an inter-glacial deposit, not by being interstratified with beds of till, but by the existence above and below it of distinct glacier-worn valleys.

These great glaciers of New Zealand, together with the occurrence of erratics and moraines in Natal, South Africa, as described by G. W. Snow,[1] indicate a time of extreme cold in the southern hemisphere, corresponding to the glacial epoch that left its records — in the form of striated rocks, bowlders, and moraines — over the northern hemisphere as far south as the fortieth parallel. The limestone of Lake Wakatipu is similar in position to the inter-glacial lignite beds of Switzerland, as described by Professor Heer, and to the inter-glacial forest-beds of Scotland and America. Geologists will notice, however, the greater age of the limestone of Lake Wakatipu, which, as indicated by its fossils, is Upper Eocene, but whether synchronal with the Eocene of Europe has yet to be determined.

The great extension of these ancient glaciers may also be owing, in part at least, to a greater elevation of the land.

Either condition returning to those rich and promising islands, they would again become wrapped in ice and snow, which would swell the ice-streams from Mt. Earnslaw to their ancient dimensions and re-create those giant glaciers.

The second glacier, like the first, had its period of great extension and then slowly passed away. As its terminus retreated up the valley it left behind it the material it had gathered from the overhanging cliffs along its course, or had torn from the sides of the valley, together with the finer products ground by the bottom of the glacier from the rocks over which it passed. This material now forms the filling of the valley below the lake, and has been worked over, perhaps many times, by streams of water

[1] Quarterly Journal of the Geological Society, xxvii. 540.

that have left it in many regular lines of terraces along the sides of the valley, which form a striking contrast with the angular crags and rocks that tower above them.

At Kingston, which is situated at the southern extremity of the lake, a huge terminal moraine, composed of cyclopean masses of angular rock, has been thrown by the glacier directly across the valley, and now forms the shore of the lake. In this confused mass of rocks we have indisputable evidence that here for a long time stood the terminal face of the glacier, which ended abruptly, as is common with glaciers at the present day, and formed a wall of ice from cliff to cliff. The reason why glaciers end so suddenly, and are thus enabled to form terminal moraines, lies in the fact that they are flowing from higher to lower and consequently warmer regions, and must eventually reach a point where the warmth is sufficient to melt the ice of which they are composed, although in many instances this limit is not attained until the glacier enters the sea. The rocks which form the terminal moraine at Kingston were once the lateral moraines on the surface of the glacier, which, as the stream moved on and was melted away, were carried over its terminal face — just as trees and blocks of ice are carried over Niagara — and were left in the confused mass that we find them.

Some idea of the time required for this truly herculean task of valley-making may be gathered from the fact that the average motion of the Swiss glaciers can be taken at about twelve inches a day, or one mile in fourteen and one half years. At this rate a block of stone falling upon the surface of the glacier of Lake Wakatipu near its source at Mt. Earnslaw, would require more than a thousand years to reach its final resting-place in the terminal moraine at Kingston, which is only midway down the valley. This mighty mill, therefore, were it now in existence, could have made but a single turn since Christ was born at Bethlehem.

As the warmth increased, the glaciers retreated to their present position around the summit of Mt. Earnslaw, leaving the valley dammed up by the moraine at Kingston, and filled by the water formed by the melting of the ice. On the sides of the valley, in many places, huge blocks of stone were scattered, similar to those in the moraine at Kingston. They also conferred the rounded form of *roches moutonnées* on the low hills and knolls along the shores of the lake.

We have, therefore, in the valley of Lake Wakatipu a striking

example of the manner in which glaciers are enabled to form lake basins, not only by the blocking up of narrow valleys by the masses of dirt and stones carried down on the surface of the ice, but also through the wearing down of the rocks throughout the upper and middle course of the glacier at the same time that they are protected from waste at the lower end by the formation of a terminal moraine. Such we conceive to be the simplest, although imperfect reading, of the grand history of Lake Wakatipu. Other great changes probably took place, however, the records of which have been erased.

Nearly the same words may be written of many other lakes which fill rock-basins, or are confined by ancient moraines, like many of the "lochs" of Scotland, and the long, beautiful sheets of water in the State of New York, of which Lakes Otsego and Seneca are examples. The glaciers to which these lakes owe their origin belonged to the glacial epoch of geologists, and were far mightier than the one whose footsteps we have traced. The excavation of the great lake basins between the United States and Canada has been traced back to the same great ice age.

Not only are we allowed to read the past history of this interesting lake, but we may also look beyond the veil that obscures its future. As the combined action of ice and water have been the instruments for its formation, so are they also working its destruction. After the formation of the moraine at Kingston the waters sought a new outlet from the valley over the falls of the Kawarau, which are constantly being worn away by the action of the water, thus tending to drain the lake to a lower level, as we see by the terraces along its shores that it has been already lowered. While the outlet is every moment becoming deeper, the streams that flow from the foot of the glaciers, together with every little rill and rivulet that is born among the mountains, is continually bringing down its burden of sediment, however small, which is deposited in the lake, and does its share towards filling the valley. If this process seems very slow, or inadequate to accomplish so great a work, we must remember that the operations of nature, unlike those of man, are not crowded into a brief life-time, but continue on through ages. The very glacier that cut this magnificent valley to the depth of a mile and a half in the solid rock, was formed of the little vesicles of mist that were wafted by the wind against the cold mountain-tops, which caused them to crystallize and accumulate on the summits as snow and ice.

The present conditions continuing, where now the deep sea-blue waters of the lake are flushed with the tints of sunset, a rich valley will one day become the home of industry, and its green fields will be animated with the flocks of the husbandman.

A COSMOPOLITAN BUTTERFLY. I. ITS BIRTHPLACE.

BY SAMUEL H. SCUDDER.

THERE is but one butterfly whose range is so extended as to merit the name of cosmopolitan; it is the Painted Lady or *Vanessa cardui*. With the exception of the arctic regions and South America, it is distributed over the entire extent of every continent. Australia and New Zealand produce a race peculiar to themselves, while the other large islands south of Asia possess the normal type, which is also found upon small islands lying off the western borders of the Old World, the Azores, Canaries, Madeira, and St. Helena. On the other hand, it has not been discovered upon the small islands off the American coast, such as Guadalupe, the Revillagegidos, and Galapagos on the western side, or the Bahamas and Bermudas on the eastern; neither does it occur in any of the Antilles, excepting Cuba, and there but rarely.[1] It is reported, however, from islands lying in the middle of the Pacific Ocean, such as the Hawaiian group and Tahiti, but its actual occurrence there is at least doubtful.[2]

[1] Cramer gives it, but probably by mistake, from Jamaica.

[2] The improbability of the occurrence of this insect upon islands lying in the middle of the Pacific Ocean has led me to look carefully into the origin of this general belief. The sole authority for Tahiti is Boisduval, who remarked forty years ago (Nouv. Ann. Mus. Nat. Hist., ii. 191) that he possessed specimens from Tahiti, Brazil, Cayenne, etc.; but it should be noticed that *V. cardui* is not now recognized from Brazil and Cayenne, and that Dr. Boisduval is not considered too careful in his geographical statements; moreover, Mr. A. G. Butler does not mention it in his List of the Diurnal Lepidoptera of the South Sea Islands (Proc. Zoöl. Soc. Lond., 1874, 274 seq.), and Dr. C. Pickering, the naturalist of Wilkes' Exploring Expedition, tells me that it was unknown on Tahiti in 1839.

The single citation of the Hawaiian Islands will be found in the first list of the British Museum Butterflies, where (p. 79) Mr. Doubleday credits four specimens to those islands, two brought by Captain Byron and two by Captain Beechey. I am informed by Mr. Butler that there is now only one specimen in the museum from the "Sandwich Islands," and the reference upon the ticket is to the oldest manuscript register, not now to be found. Byron and Beechey were at the islands in 1825–27. Mr. W. T. Brigham informs me that *V. cardui* was not found by Mr. Mann and himself during a twelvemonth's residence at the islands ten years ago, and I can find no authority for its present existence. Dr. Pickering writes that it was unknown when Wilkes's expedition visited the islands in 1840–41. The Vincennes, to which Dr. Pickering was attached, was at the islands from the end of September to the beginning of April. Byron and Beechey's visits were between the latter part of January

On the American continent, its southern boundaries will probably be found in Venezuela, New Grenada, and Ecuador,[1] but it is abundant even as far south as the highlands of Guatemala, and thence stretches northward over the entire breadth of the continent to the arctic regions; on the eastern coast it has been found as far as Labrador, and on the west to the eastern shores of Behring's Straits.[2] In the heart of the continent I have taken it upon the Saskatchewan, and Doubleday reports it from Martin's Falls; but Mr. W. H. Edwards does not recollect seeing it in the few collections he has examined from points farther north.

As we see it flourishing in the colder regions of Europe and North America, so also is it found on all mountain heights; and Mr. H. W. Bates, writing of the whole genus, distinctly says it is "found only in elevated places in the neighborhood of the equator." The stations in Southern Asia from which *V. cardui* has been reported, — Cashmere, Nepaul, Bootan, and Sikkim, — all lie on the flanks of the Himalayas, and the Nilgherry Hills are the highest elevations of the Indian peninsula. In the Alps of Europe this insect flies to the snow level; but in North America, although it may be regarded as one of the commonest butterflies in the elevated central district, it is most abundant at a level of seven or eight thousand feet. Lieut. W. L. Carpenter and others have never found it above the timber line; but Dr. A. S. Packard, Jr., has taken it on Arapahoe Peak, between eleven and twelve thousand feet, and on Pike's Peak from eight thousand feet to within five hundred or a thousand feet from the summit.

We naturally inquire, Where did this cosmopolitan creature originate? Judging from its present distribution alone, we should probably answer: In the temperate parts of the Old World; because in the New World it has penetrated but a short distance into South America, and has established no colonies upon the neighboring islands, excepting on Cuba; while in the Old World

and the middle of July. Mr. Butler does not consider the specimen in the British Museum, nor the record of Doubleday, sufficient authority to include this insect in his list of South Sea butterflies. Upon the whole, we cannot fairly accept the present authority for the presence of this insect in the Pacific Islands.

[1] Wagner took a single specimen near Quito in an eight months' residence there.

[2] This statement is made on the authority of Wagner (Sitzungsb. k. b. Akad. Wiss., 1870, ii. 170), but at the same time he asserts that this butterfly is found on "all the Aleutian Islands," which is certainly incorrect. Lieut. W. H. Dall, whose natural history explorations in Alaska are well known, writes very positively that there are no macrolepidoptera whatever on any of the islands west of Unalashka; a fact he easily explains by the absence of trees or shrubs, the strong winds and the wide straits that separate the islands. East of Unalashka he knows of but two butterflies, a Pieris and a Polygonia.

it has not only crossed the equator, and colonized many of the islands of the Indian Ocean, but has founded a race beyond in Australia and New Zealand, and has reached many of the small islands lying off the coast of Spain and Africa, not to mention the questionable report of its presence on the Hawaiian islands and Tahiti, the affinities of whose populations are with the Old rather than with the New World. But this reply is not wholly satisfactory, although most writers in discussing its distribution have assumed an Old World origin.

To answer this query fairly, we must examine the distribution of the other species of the genus. At first we seem to gain little aid from this source, for we are perplexed by finding that another species, *V. Atalanta*, is also an inhabitant of two worlds, although confined almost exclusively to the north temperate regions of both, which seems a new complication; and, again, that the other species of the genus share between them nearly the entire globe. Thus in the Old World *V. Indica* is found in the region that bears its name; *V. Dejeanii* in the Malayan Archipelago; *V. Itea* in Australia and New Zealand (into which latter island it has probably spread from the former); *V. Gonerilla* in New Zealand; *V. Tammeamea* in the Hawaiian Islands; *V. Abyssinica* in Northeastern Africa; and *V. Hippomene* in Southeastern Africa and Madagascar. While in the New World, *V. Huntera* is found in North America, east (and to a slight extent west) of the Rocky Mountains; *V. Carye* west of the Cordilleras from California to Chili; *V. Myrinna* in the tropics of South America, east of the great mountain chain; and *V. Terpsichore* at the southern extremity of the continent.

But the species of the genus Vanessa (and all the recognized forms are here enumerated) fall into two natural groups: one of these contains such species as have upon the dark upper surface of the wings a conspicuous, bright-colored bow, crossing the middle of the fore wings and skirting, somewhat narrowly, the border of the hind wings; while the other comprises forms on whose upper surface the bright colors (usually some shades of red) nearly or quite predominate, but are broken by the darker parts into irregular blotches on the fore-wings, and form the ground color of the entire outer half of the hind wings, so that all effect of the somewhat regular bow of the other group is lost. There are further differences between them; the species of the former group have the paronychia distinctly bilaciniate, as pointed out by Doubleday; they have also the upper abdominal appendage

bifid at tip, and their caterpillars live in a nest formed by drawing together the edges of a single leaf; while those of the latter have the inner lobe of the paronychia rudimentary, the upper abdominal appendage simple, and their caterpillars live in nests formed of many leaves.

Now *V. Atalanta* falls into the former section, and *V. cardui* into the latter; and if we put out of consideration for the moment the distribution of these two butterflies, since they occur alike in both worlds, we find that all the species of the first group are Old World species (including *V. Kammeamea*), and all the species of the second group are New World species. It is difficult to avoid the conclusion, therefore, that these two insects originated, each where its nearest congeners are exclusively found, namely, *V. Atalanta* in the Old World and *V. cardui* in the New; or, using the facts of distribution still further, *V. Atalanta* in Europe and *V. cardui* in North America.

That *V. cardui* should be found upon many of the outlying islands of the Old World, and upon almost none of those which surround its birthplace, is not a matter of much surprise. The butterfly-fauna of islands which have little or no indigenous population is almost altogether made up of a few species of great endurance and which hibernate as butterflies (that is, are longer lived than others in the imago state), and it seems pretty certain that their presence there at all is an accidental circumstance. Mr. J. M. Jones has recently given [1] a very interesting account of the sudden appearance in Bermuda of large numbers of *Terias Lisa*, a delicate-winged butterfly, common enough in the southern United States, but hitherto unknown to Bermuda, where he has detected only *Anosia Berenice*, *Danaida Archippus*, and *Junonia Cœnia;* and he very reasonably accounts for the sudden appearance of these little butterflies by supposing them to have been caught up by the winds in a period of great atmospheric disturbance, and whirled over the sea to this island. Another writer tells of the visit, during a cyclone, of numerous birds and insects to a ship six hundred miles from the African coast and two hundred from the Cape Verde Islands; among these were two butterflies, *Diadema Bolina* and *Vanessa cardui*, the latter at least not yet recorded from the Cape Verde Islands. Other instances might be given, but from these alone we may reasonably suppose that of the myriads of insects which perish from such accidents, a few now and then reach and people some hospitable shore.

[1] Psyche for November, 1875.

Considering the wide and even tropical distribution of *V. cardui* in the Old World, its absence from South America seems not a little remarkable. But the species of cosmopolitan genera not very rich in species (like Vanessa) are generally conterraneous, or they occupy adjoining zoölogical provinces as equivalent species, species of replacement, or, as the Germans sometimes call them, vicarious species. But we have already seen that, if we leave out of account our cosmopolitan species, and restrict *V. Atalanta* to the Old World, where it actually belongs, each of the species of Vanessa occupies a separate zoölogical region, one adjoining another, over nearly the entire extent of either world. The cosmopolitan species, similarly restricted to the New World as its proper habitat, occupies nearly the same region as *V. Huntera*, extending no doubt farther north, and becoming less abundant toward the southern extremity of the common limits of the two, phenomena which are repeated in the distribution of our two common and wide-spread eastern species of *Argynnis*, *A. Cybele*, and *A. Aphrodite*. The absence of *Vanessa cardui* from South America is therefore rather an argument in favor of its American origin. The presence of the insect on the shores of Behring's Straits, as testified by Wagner, is an indication of its route from America to Asia; and this passage must have taken place in times so far distant that it has had opportunity to push its way even to Australia and New Zealand, and there to become so modified as to establish a peculiar race, once dignified by a specific name. If its presence in the Hawaiian Islands can be proved, such a fact would be more difficult to understand; but we can hardly doubt that *V. Tammeamea* and the other Old World species of Vanessa sprang from one original stock; and if the progenitors of the Hawaiian Islands species found a track from the Asiatic continent, so, plainly, could *Vanessa cardui*.

THE LOBSTER; ITS STRUCTURE AND HISTORY.

BY J. S. KINGSLEY.

AS the season of summer schools is approaching, it has been thought advisable to give a short account of the anatomy of the lobster. This animal has been chosen not only on account of its size and the ease with which either it or its fresh-water cousin, the crayfish, can be obtained, but also from the intermediate position it occupies in the articulata, forming an important type of this branch of the animal kingdom. A few technical terms

have been employed, since there is a lack of common names, to aid in explaining the homologies of the various parts.

At the first glance the lobster is seen to consist of a large anterior portion, bearing the pincers and various other appendages; and a posterior jointed portion, the abdomen. Taking the third segment (*somite*) of the abdomen as a starting-point, it is seen to consist of an upper (*tergal*) and an under (*sternal*) portion. The portion of the segment between these two is called the *pleurum*. On the under side, inserted between the sternum and pleurum, is seen a pair of appendages, the swimmerets (*pleopoda*). Each consists of a basal portion (*protopodite*) and two oval fringed paddles, of which the inner is the *endopodite* and the outer the *exopodite*. This we will consider as our typical segment, that is, we will try to show that all the other somites are formed on the same plan, with more or less variation of detail. In the sixth abdominal segment these swimmerets will be seen to be greatly enlarged, and the exopodite has a transverse joint. The seventh or last segment (*telson*) has no appendages. Together with the pleopoda of the sixth it forms a paddle by which the animal is enabled to propel itself backward in the manner familiar to all who have ever observed these animals when alive. The pleopoda of the first abdominal somite are also modified; in the female they are small, slender, and soft; in the male each consists of a hard protopodite and endopodite, the exopodite being absent. The endopodite of the second segment in the male lobster bears an additional joint on the inner side.

We now come to the anterior portion of the body, in which the segments are not so distinctly marked. It is covered with a large dorsal shield, the *carapace*. In front it is produced, between the eyes, into a long spine, the *rostrum*. In the middle is a groove which indicates the position of the heart in the interior. It certainly does not indicate the line of separation of the head and thorax.

We are enabled to separate the anterior portion into somites from the fact that for every pair of jointed appendages there is a corresponding segment. Proceeding forward from the abdomen with our homologies, we first find the fifth or last thoracic limb, which differs greatly at first sight from the swimmerets. It consists of a protopodite and a jointed endopodite; in its earlier stages it had also an exopodite. With the thoracic limbs a new feature appears; to the limb or the sternum at the base of the limb are attached one or more conical appendages consist-

ing of little lamellæ fastened together, forming a gill. These gills are packed away under the carapace. There are twenty on each side. The fifth limb bears one. In the fourth we find still another organ, a thin leathery structure with scattered hairs, the *epipodite*, the function of which is to keep the gills apart. This limb bears four gills, as do the third and second. In the second and third limbs the inner distal angle of the next to the last joint is greatly elongated, forming with the last joint a pincer or *chela;* limbs thus formed are said to be *chelate*. The first pair of thoracic limbs are greatly enlarged, and it is the outer instead of the inner angle of the joint next to the last which is elongated to form the pincer. It bears three gills.

We now come to the appendages of the head, and among them we again find the exopodite. The six posterior pairs are commonly called the "mouth parts." We first find, in going forward, three pairs of *maxillipeds*, each composed of a protopodite, exopodite, and endopodite. The outer pair are larger than the others, the basal joints are hard and toothed like a saw; they bear each three gills. The second pair bear one small gill and the third are gilless. In front of the maxillipeds are the two pairs of maxillæ. They are delicate, almost membranous. The epipodite of the posterior one, called *scaphognathite*, is in life in constant motion, baling out water from the gill cavity, thus creating a current over the gills and aiding in respiration. We next come to the mandibles, a pair of hard protopodites with cutting edges, and a delicate three-jointed endopodite termed a *palpus*. Between the mandibles is the mouth. It is bounded behind by a bifurcated process, the *metastoma*, and in front by a simple enlargement, the *labrum*. In front of the mouth the sternal surface bends abruptly upward. Above this flexure we find the larger antennæ, which consist of a protopodite and endopodite, the exopodite being represented by a small spine. Still farther in advance are the smaller antennæ, called the antennulæ. This finishes the number of segments. Reviewing, we see that we have eight cephalic, five thoracic, and seven abdominal. It will be seen that the writer does not recognize any segment corresponding to the eyes, and that he believes the telson to be a somite. The reasons for the former are chiefly embryological; for the latter, the fact that the intestine passes through it, together with certain reasons derived from the development of the young lobster. The mere absence of appendages has no great weight.

The internal anatomy is best studied by removing part of the carapace and tergal portions of the abdominal segments, as shown in the plate, taking care not to injure the underlying organs. Beneath the shell will be found a reddish membrane, which must also be carefully removed. The heart will be seen to be an irregular hexagonal body, lying just behind the suture noticed in speaking of the carapace. It consists of a single ventricle contained in a sac improperly called the *pericardium*. It gives off in front an artery to the eyes and anterior part of the body. Close to this on each side is the hepatic artery. On the under side is the sternal artery, while from the posterior angle arises the artery which supplies the abdomen. The sternal artery connects with one which runs the length of the body on the under side. Respiration is carried on in the gills. The heart forces out through these various arteries the blood, which collects in a *venous sinus*, passes to the gills, and then back to the heart.

In front of and surrounding the heart is a delicate, convoluted mass, the liver, which occupies a large proportion of the thoracic cavity. In it are imbedded two elongated bodies, *ovaries* or *testes*, according to the sex, which pass under the heart. They are connected in front of the heart. Behind this connection are the *oviducts* of the female or *vasa deferentia* of the male.

The mouth, the position of which has been noticed, is connected with the œsophagus, which in turn empties into the stomach. This latter is a large sac in the anterior part of the body, and consists of anterior and posterior (*cardiac* and *pyloric*) portions. In the cardiac is a complex calcareous organization operated by powerful muscles, the office of which is to finish the mastication of the food. In the pyloric portion is a ciliated strainer. The intestine is a straight tube extending beneath the heart from the pylorus to the anus, which is situated on the under side of the telson. At the base of each antenna is the "green gland," supposed to be a kidney; it communicates with the exterior by an opening in the protopodite.

The "brain" is found at the base of the rostrum, between the eyes. It gives off nerves to the eyes, the antennulæ and the antennæ. From the posterior portion are given off two commissures, which pass around on either side of the œsophagus and unite in a ganglion behind. To examine this and the succeeding thoracic ganglia, it will be found necessary to carefully break down part of the sternum. From each of the œsophageal commissures

arises a nerve, the two uniting in front of the stomach and giving rise to the sympathetic nerve. From the infra-œsophageal ganglion arise the nerves which go to the mouth parts. The thoracic ganglia are connected by two commissures, the abdominal by a single cord. The sternal artery passes between the commissures, uniting the third and fourth thoracic ganglia. There is no ganglion for the telson.

The only senses which are localized in the lobster are sight and hearing. The position of the eyes has been noticed; the ear is found as a small sac in the base of the antennulæ.

Space will allow but a slight account of the development; for details the reader is referred to the papers of Mr. S. I. Smith, in Verrill and Smith's Report on the Invertebrata of Vineyard Sound, and in the Transactions of the Connecticut Academy of Science. (See also the NATURALIST, July, 1874.) The eggs are of a dark green color, and are found from April to November on the coast of New England. The embryo in the egg has its eyes sessile, its antennæ are simple sacs, and its abdominal feet are wanting. In the first stage after leaving the egg the thoracic feet are furnished with an endopodite fringed with hairs. The animals then swim on the surface. In the second stage some of the abdominal appendages appear. In the third it loses its exopodites, and begins to resemble the adult. Specimens three inches long have been found with nearly all the characters of the adult. During the first year the molts are quite frequent, but afterwards they are believed to occur but once a year. The carapace splits down the back, and through the opening the animal withdraws itself, leaving its œsophagus and stomach within the cast-off skin, and in a few days the new skin becomes hardened.

EXPLANATION OF PLATES V. AND VI.

Plate V. Fig. 1, carapace; 2–8, abdominal segments; 2′, side view of the first abdominal somite of male; 9, antennulæ; 10, antennæ; 11, mandibles; 12, 13, maxillæ; 14–16, maxillipeds; 17, big pincer; 18–21, remaining thoracic feet; 22, front view of third abdominal segment; 23, transverse section through the carapace.

Plate VI. Fig. 1, dorsal view, part of the carapace removed, giving a schematic view of the internal anatomy, a portion only of each organ being represented; 2, nervous system; 3, diagramatic figure of the circulation (from Gegenbauer); 4, embryo in the egg (from Smith); 5, first stage of young (from Smith).

E, eye; ex, exopodite; en, endopodite; ep, epipodite; f, flexor muscles; g, gill; h, heart; h. a, hepatic artery; i, intestine; l, liver; m. a, anterior median artery; n, nerve; p, protopodite; p. a, posterior artery; p. c, pericardium; r, rostrum; s, stomach; t, ovary or testes; v. a, ventral artery; s. a, sternal artery: v. s, venous sinus; x, extensor muscles.

THE PROBABLE DANGER FROM WHITE ANTS.

BY DR. H. A. HAGEN.

I INVITE the reader to imagine himself in a forest in the interior of Brazil. There is a clearing in the forest. A small valley covered with underbrush, and containing a fresh water pool, opens before our eyes. Here and there are scattered little hills several feet high, more or less covered with grass. Thick clouds rise slowly and make the close air still more oppressive; the rainy season, the disagreeable summer of the tropics, is approaching. All seems quiet, but suddenly one's attention is attracted by a strange activity beginning in one of the little hills.

As if by witchcraft, a cleft opens in the middle of the hill. A little brown insect comes out with folded wings, followed by two, three, four, and more, in one row, as many as the quickly widening cleft will allow to pass at once. Like a silver ribbon the train winds down the hill, for the membrane of the wings glimmers like mother-of-pearl. These insects take a course just opposite to the wind, as this is the only way in which their delicate wings can resist the pressure of the air. More and more, without interruption, appear hastily, as if driven out of the hill. Other similar clefts have been opened, from which similar trains throng out. The little hill seems to discharge its living lava like a volcano. But the most curious spectacle is seen near the cleft. There appear little wingless creatures with enormous heads and hooked jaws, which they move threateningly, to defend the entrance to their subterranean chambers, and to accelerate the march of their brethren who have been turned out. At last the rows grow smaller and thinner and the clefts begin to close as if walled up by invisible hands. In the mean time the swarm has tried its wings, and rises steadily into the air, keeping close together near the tops of the trees and then gradually falling to the earth. Pretty soon the number of the falling insects increases, and we notice that they are always in couples, male and female, running quickly about and trying to get rid of their loosely attached wings.

Continuing to observe the strange kind of emigration of these insects, commonly called white ants, we find that only a few of these myriads live till the next morning. All those that have not been eaten by the large numbers of mammals, birds, and reptiles eager to swallow them have been caught by the busy

workers of the white ants, and elected as heads of a future family. A clay cell, shaped like a watch-glass, serves for the royal pair, first as a dwelling and later as their grave. They are never allowed to leave it. The entrance is carefully walled up, and at first only one small hole is left for the workers to go in and out. Food is brought in and consumed. The queen grows visibly, and begins soon to lay the eggs of the coming brood. The number of eggs is immense; the statements vary between eighty in every minute and eighty thousand in twenty-four hours. As the same queen continues to lay eggs for two years, at least in some species, some forty millions of eggs will have been laid during this time. This large number is not exaggerated; indeed, the fecundity of some common insects goes much beyond this. The common blue-bottle fly has in one summer five hundred millions of descendants, and the plant-louse has in one year, in the fifth generation, six thousand millions, and still continues to lay eggs when the ninth generation is already fit for propagation. Among the vertebrates some fishes have a comparatively numerous progeny.

The growth of the queen increases in proportion to the number of eggs forming in her body. When full-grown she is several thousand times as large as before; that is, her abdomen only has grown from one half an inch to six and even eight inches in length. The whole body resembles a thick worm, covered at regular distances with brown spots, the former segments of the abdomen. The delicate feet are completely unable to move the body, out of which the eggs are forced by an incessant peristaltic motion.

Meanwhile the cell of the so-called queen has been widened according to necessity. A gang of workers, forming a chain, moves about the floor and carries the eggs into the nurseries near by. To shorten the way they make little holes in the walls of the cell at regular distances. Soon we find a motley crowd crawling about in the nest; very young larvæ, workers and soldiers, two aborted forms of both sexes, nymphæ, and later, mingled with them, the full-grown winged imago.

But the nest has become too small, and we now see similar hills rising near by; then the partition walls are broken to connect the new dwellings with the old ones; and additions to the family force the brood to repeat the operation. Larger species in the tropics raise hills to twelve feet and more in height, strong enough to resist the influence of the tropical rains, and to render difficult their destruction by men or animals.

The whole is built up by the blind workers in the dark, for it is a peculiarity of the white ants that they shun the daylight. No matter how far they intend to go, they build *a pipe of clay* of about a quill's diameter, forming a viaduct, the inside of which is quite smooth, whilst the outside is more or less rough. It is wonderful how quickly the work progresses. In a file each worker carries to the right place a small particle of loam, mixed with its saliva. Without interruption the little troop is busily engaged, and such pipes have been observed to progress two inches in a single hour, and six feet during one night.

When the work is damaged, the workers retire, frightened, and in the breach appear the thick-headed soldiers; first one, then more, in such a hurry that often the foremost are thrown down by the eagerly pressing crowds. Opening their jaws wide, they move their heads threateningly to reach the enemy, and at the same time make a peculiar hissing sound. Furiously they beat at everything in their way, and not infrequently put to flight barefooted intruders. The soldiers do not help at the work; protection is their only duty. They are blind, like the workers.

There are some very curious facts observed concerning the instinct of these little animals. As the whole nest would die with the premature death of the queen, sometimes two equally well-developed queens are found in the same cell, but the rather impolite workers have built between them a partition, beginning at the ceiling but not quite reaching the floor. Therefore only conversation is possible; perhaps they think that two queens would not live peaceably so near together. Every society provides carefully for a substitute in case of the queen's death, and in a small cell, shaped like that of the queen, two or three individuals are found, prepared, if wanted, to take her place.

All the species of the white ants which build hills belong to the tropics. But besides these, there exist numerous species which build curious nests in the tops of trees, or beneath the surface of the earth, or which live in decayed trees and in every kind of decayed wood. Two of the latter kind, very similar to each other, live in Europe and North America; and about these in particular, and their dangerous habits, I propose to make some observations.

The European species (*Termes lucifugus*) has been observed by naturalists for nearly a century. The little dark-brown insect, living under stones or in old decayed trees, had until recently never

been injurious. Even its appearance in myriads after the falling of an old uninhabited house in Rochefort, in France, did not draw the attention of the people to the danger. Some time afterwards more accidents happened. In a boarding-house a whole dinner party fell suddenly from the third story down into the cellar, and some other buildings threatened similar mishaps. The danger was increased, as each owner carefully denied having these fearful guests, for fear of depreciating the value of his house. The anvil of an industrious blacksmith yielded under his hammer, and the block supporting it broke to pieces, entirely destroyed by white ants. The attention of the government was drawn finally to the danger by the destruction of the costly timber stored in the navy yard for the building of men-of-war, and the destruction of the naval archives. Several times scientific commissions were sent to investigate the new pest and to propose remedies; and scientific societies in vain offered prizes for the fortunate destroyer of these animals. Nevertheless every remedy proved useless, as refuse and manure spread the obnoxious insects further. Constant attention and the destruction of the pipes, and use principally of only metal and stone for the construction of new buildings, were considered the only remedies against the white ants. Some years later they did less damage, and disappeared, as insect pests commonly do, without any known reason. For the last twenty years they have existed everywhere in the formerly infected departments, but without being obnoxious.

The North American species (*Termes flavipes*) in form and color is very much like the European, but differs in the more yellowish legs. The species has been known to science since the end of the last century. Their obnoxious power was first shown in Europe, in the beautiful hot-houses at Schoenbrunn, belonging to the Emperor of Austria. The insect was believed, probably by mistake, to have been imported with plants from South America, for till now this species has not been observed south of the North American continent. It was not possible to get rid of them in Schoenbrunn, in spite of great expense and careful labor. One of the largest hot-houses was so nearly destroyed by them that it had to be torn down to prevent its falling to ruin. Besides the beams, they had destroyed the tubs in which the plants were set. The new hot-houses were built of iron, but the white ants are still living in them.

The whole region of the United States east of the Rocky Mountains possesses only one species, the above-mentioned *T.*

flavipes, spreading from the Gulf to the Lakes, and from the Atlantic to the westward beyond the Mississippi. This white ant seems to be common everywhere; it is very abundant in New England, and from my personal observation is to be found everywhere around Boston, in its suburbs and in the surrounding country, within a radius of ten miles. It lives in old stumps, in dead trees, and in fences, logs, and every kind of rotten wood. So far as is known, living trees are not attacked.

The full-grown insect swarms in June more or less numerously, and nearly every year local newspapers give some account of an irruption. Curiously enough, and although many observers were eager to follow the insects to their nest, till recently none had been discovered. Only a few months ago, in the southern part of Florida one was found by chance in an old rotten log, and the queen sent to the Cambridge Museum. I have tried to discover the nest here since I was invited to come to Cambridge by the late Professor Agassiz, and I have repeatedly given serious attention to this subject. But I never succeeded. I beg to mention only one of my experiments. A board which lay about twenty steps from the corner of the museum when I arrived, eight years ago, was left in the same spot five years for the purpose of covering wet places in the spring and in the fall. Suddenly in June, 1872, it proved to be infested and covered with thousands of white ants. Of course they must have come through the ground, and I tried carefully to discover the passages and holes, in order to find a clew to the nest. The whole ground beneath the board and its neighborhood was examined, and the loam carefully displaced. But no trace was found. I have no doubt that some old stumps in the surrounding estates will be the right place, but they are too numerous to enable us to find the right one. The only scientific conclusion to be made is that the white ants spread commonly very far around their nest underneath the ground, and appear above as far as possible from the nest. It is very obvious that by this habit the danger is aggravated, and the remedy, that is, the destruction of the nest, difficult to apply.

My inquiries as to whether there had been observed any mischief done by white ants here were always answered in the negative. Only one fact was known. About ten years ago, in a hothouse at Salem, the grape-vine was destroyed by them, and curiously enough in the same way as in Europe, and I am informed that the sills of houses and decaying trees in that city are

tenanted by them. Two years later I was presented by the late B. Walsh, in Rock Island, with a copy of the state papers of Illinois, which were destroyed by white ants. All the spare copies were stored in a closed room, and not looked after for some time; when the room was opened all were found in the same condition. I can never look upon the volume without being puzzled by the remarkable fact that the queer little rogues failed to attack the name of Vandalia on the top of the pages. Several years later a Boston lady, a teacher in one of the freedmen's schools in South Carolina, who had gone away for a vacation of six weeks, found, on returning, the whole library destroyed, Bibles and prayer-books. The copies kindly forwarded to me were less damaged, and therefore retained.

Here, around Boston, old fences are the favorite dwelling of the white ants. The old fence around the Observatory in Cambridge was the easiest place to collect them. The fence was replaced last fall by a new one. In the report the expense was marked down as a large one. If we consider the danger to the library and the records of the Observatory, which, once destroyed, never could be replaced, we shall agree that the expense is a real benefit. In the Botanical Garden, white ants are equally numerous. A few years ago I had the opportunity of seeing white ants swarm in clouds in the Botanical Garden. A whole army ascended the steps to the herbarium. I was frightened by the possible danger to this treasure. But the answer that all the plants in the herbarium were poisoned turned directly my compassion to the side of the little strolling wanderers. Nevertheless, the costly library of the Botanical Garden is certainly not poisoned, and doubtless somewhat in danger. I tried to find the centre for the large distribution of white ants around the Observatory and the Botanical Garden, and I believe I am right in regarding it as existing in a very old estate just opposite to the Botanical Garden. Near Spy Pond I had for several years a good collecting place for white ants in a venerable giant of pine, dead perhaps for many years, but removed the last winter; in the many old stumps around it, however, the nest was not discovered.

Near Winchester, on Mystic Pond, the fish commission has built a remarkable fishway for alewives, near a sluice. Two years ago I examined the posts and stumps around it, and found them infested with white ants. Till now they have done no damage. I have no positive information that mill-dams are damaged by white ants, but I cannot help believing that at least

in some cases of ruptures of dams, so frequent of late years, white ants may have had some part at least in helping the destruction. The same remark applies to wooden bridges. I can only give one fact which I believe belongs here. Near Porter's Station, in Cambridge, was a wooden bridge for cattle driving, which gave way, as it was stated, by a large number of cattle running across it. Trains stop forty times or more daily at Porter's Station, and the bridge was so situated just above the engine that it was moistened by the hot steam, the best accommodation which white ants would choose. I am told that the broken wood had been sound, but I can state that white ants swarmed last year on both ends of the broken bridge. Even now the outside of the old bridge remains near the newly-built one, and the wood is thoroughly rotten and eaten by insects. I have always wondered that houses were never attacked. Now it is done. Some years ago, Mr. Alvan Clark, the world-wide known maker of astronomical instruments, visited the Museum of Comparative Zoölogy. When I showed him the biological collection of white ants, he told me that he knew them very well, because they swarmed every year in January in his workshop. Afterwards, while I was on a visit there, he showed me that the timber around the furnace in his shop was entirely infested by them. This year, suddenly the ceiling above the furnace, where the wood is constantly moistened by hot steam, gave way for about an inch, and he was obliged to support the whole by posts and jack-screws. A gentleman from Roxbury, when I showed him wood damaged by white ants, told me that an old shanty on his estate came down, and the wood looked just like the piece I showed him. From some lumbermen I heard that such wood was known by the name of powder-dust, and I found beautiful pieces of it among large piles of lumber near Lake Winnipiseogee. I am happy to state that I know of no other damage done here by white ants. But their habit of working without injuring the outer surface of the eaten wood, and the immense damage done by a nearly-related species, makes it a duty, I believe, for everybody to be on his guard. White ants are every year swarming around the Museum of Comparative Zoölogy, the Botanical Garden, and the Observatory. Collections and large libraries are in the neighborhood, and it should not be forgotten that A. von Humboldt stated half a century ago that the rarity of old books in New Spain was the consequence of the depredations of white ants. I have no proof that white ants are living in the city of

Boston itself, but there can be no doubt of it. Old posts, plankways, fences, stumps, are everywhere their favorite dwelling, and there is no lack of this sort of rubbish in many places. In East Boston their appearance was recorded several years ago by newspapers.

The question, What can be done to prevent as much as possible the danger? is a natural one. I have thought much about what should be recommended, and I will try to give some hints which may perhaps be accepted. The remedies (the large number of which shows their insufficiency) recommended for the destruction of white ants in the tropics fill a whole literature. I will not forget to mention that as every calamity is used by rogues to cover their bad doings; even the destruction by white ants was used in such a way. When a very large property, stored by the government in Isle de France, was reported as destroyed by white ants, the ministers sent to the officers a box containing files, with the strict order to file off the teeth of each ant or to resign the place. Since then the white ants have been harmless, at least comparatively so.

The substance of the propositions recommended by me would be as follows: —

(1.) We must know that we live surrounded by such enemies, and that great destruction can be done. If we look straight in the face of an enemy and know the power he can develop, the battle is half won. Nothing is more dangerous than underrating or overlooking the power of even the feeblest enemy.

(2.) We must not try to find a remedy to exterminate them entirely and at once. Such exertions are fruitless. We must try to diminish the danger to the smallest possible degree. The life of man is a continuous struggle with a host of enemies which he cannot exterminate. They must be avoided or conquered.

(3.) The remedy must be a reasonable one. For instance, it would be absurd to recommend not to build houses of wood in a country where certainly wooden buildings are the most healthy, considering the great changes of temperature, the great humidity of the air, and above all the convenience of such houses.

The diminishing of the progeny of animals is done in the simplest way by depriving them of food. Now the food of white ants is principally old rotten wood, and I think the first step should be to take away all that is possible of such stuff. Old stumps are the principal dwellings for white ants, preserving them through the winter. Therefore every old stump should be

removed, at least near cities and towns. For old fences, I believe this will be more difficult, but I see no other help, at least near cities and towns. It should not be overlooked that a sudden removal of a large quantity of such infested wood might bring about a sudden calamity by a larger spreading of the disturbed and starved animals. But it should also be considered that in deferring this necessary remedy the evil would be greater, and only postponed; the ants would spread more and more, and a later generation would deplore the lack of attention given by their forefathers. I think if the removal was effected in winter time, when the ants are weaker, and a large part would die in the cold weather by exposure, or by simple chemicals put in the hole, the danger would not be so great that it could not be overcome. Of course I would condemn also all useless pieces of wood lying around, also old forgotten shanties and similar structures.

A very important point would be not to have well-manured flower-beds just around and near to the wall of wooden dwelling-houses. The soil in such beds is always less compact and warmer, and I have observed in such beds in the early spring swarming white ants. I think it would be best to have around the houses for a certain distance clay or gravel, as the white ants do not seem to like them.

It should be remembered that in railway depots and stations the engines should not stop daily on a spot where bridges or similar wooden structures are moistened by the steam. Of course the same precaution would be commendable in manufactories.

These seemingly not very significant measures, if followed strictly, would, I think, prevent the greatest part of the danger. Continued attention would be the principal, and this would be easy, as the swarming of the white ants in the summer indicates to every one their presence.

I should be sorry if the lugubrious picture of the possible calamity, which may seriously endanger a flourishing country, should be thought too darkly shaded or perhaps sensational. This has of course not been my intention. I have only tried to draw attention to an enemy with which we have lived until now peaceably, without knowing its dangerous power, a power which can be developed at any time, if precautions are not taken to destroy it.

White ants are only the police of nature. If mankind takes the police in his hands, nature steps behind. White ants retreat step by step before the advancing culture. In Africa and India,

where a century ago immense ant-hills were to be found near the shore, now some days' journeys inland have to be made to find them. We are justified in hoping for this retreat of white ants here, in front of a rapidly advancing culture.

EXPLORATION OF A MOUND IN UTAH.

INFORMATION having been received that a mound existed on Santa Clara River, a few miles from the village of St. George, in Southern Utah, which from its position promised to yield interesting results, it was deemed of sufficient importance to have it explored. Dr. E. Palmer, being in that neighborhood last fall, was requested to direct the operations in the interest of the National Museum. The report which he submitted gives interesting details of what he observed during the progress of the work, and his impressions explanatory of the same.

With the necessary workmen and tools he proceeded to the mound in question, on the east side of the Santa Clara River, about three miles from St. George, Utah, and camped at its base. A general view of the situation showed an isolated elevation which had originally covered about half an acre of ground with a varying height of ten or twelve feet, which had been cut away nearly one half on the side of the river by the action of its waters during a freshet in 1861 or 1862. The outline it presented on the ground was quite irregular. The rise in the river had changed the position of the channel, and deepened it and also made it wider. At this time, however, the stream is reduced to a very small width, say from twelve to fifteen feet. What remained of the mound was quite a conspicuous object in the landscape, about forty feet from the river-bed, with a vertical escarpment on that side, but evidently it had been a circular work before its partial demolition by the river. The lines of stratification seen on the river front were conclusive as to its having been piled up by human agency, showing various horizons from the base up, on which dwellings had been erected and occupied by the residents of the spot until some member of the household, probably the head, should die, when it was burned down with all its appurtenances, the dead body included; leaving a deposit of ashes with incombustible stone implements to designate the location.

The construction of the dwellings was studied out on the spot and was found to be for the most part of upright sticks or staves,

probably wattled, supporting a roof made of slender poles, which sustained a grass thatch covered with mud for the outer layer. Others had a stone wall or foundation, laid up with clay mortar. The included space was square, shown by a well-defined line of ashes where the walls had been burned down, with bits of charcoal scattered over the surface which were derived from the poles of the roof, while over all was an almost continuous layer of clay, burned to the hardness of soft brick, which had covered the roof. These brick-like masses still preserved the impress of the wood upon which the clay had been plastered. The amount of ashes in each little inclosure differed somewhat, in proportion to the thickness of the roof, and the quantity of household implements or provisions which it may have contained at the time of the conflagration. The location of the domestic hearth seemed to be distinctly shown by the accumulation of a mass of ashes, semicircular in form, and ten or twelve inches deep. In several instances large flat stones were found neatly arranged around these fire-places, as if to retain the fire in its proper limits. Other inclosures or pens of slabs of rock were noticed, and were interpreted to be storing places for provisions. All the rock material used in and about the buildings was brought from a distance, probably by water-carriage on the river, there being no stone quarry near the place. There could not be discovered any regular disposition of the buildings in rows, circles, or around a square, but their location seemed to have been determined by some such event as the burning down of one dwelling, and the necessity of erecting another in some quarter at a distance, for the occupancy of the survivors.

Some portion of the skeleton of the cremated Indian was always found within the inclosure marked out by the lines of ashes. The effect of the fire had been to destroy the body, and what remained of the bones crumbled on exposure to the air; a portion of one or two crania being all that could be brought away. Many other objects were also found, such for instance as stone mortars, metates, pestles, grinding-stones, flint arrow and spear heads, earthenware jars, and such other Indian implements or property as could not be destroyed by the fire.

Adjacent to the skeletons was found what was judged to be an intended provision of water and food, arranged in appropriate vessels; those for water being generally of the same globular shape. The vessels were of hard-burnt earthenware, for the most part of a grayish color and ornamented inside with parallel black lines, with occasional triangular or quadrangular black spots.

These pots or jars or bowls, to the number of three, five, seven, and ten respectively, were discovered in connection with remains of the dead, as the several house floors were dug up and cleared away. In a few instances no earthenware was discovered; small deposits, however, of substances which were charred or otherwise decomposed pointed out where provisions had been left for the sustenance of the departed spirits. Throughout the whole mound refuse bones from food-animals of many species were discovered, and all exhibited signs of being split for marrow, or otherwise worked or handled.

Before any of the tribe to which the deceased belonged could be induced to erect another dwelling on the old site, much time, probably a generation or two, would have to elapse. In obedience to a powerful superstition and fear of the dead no one would be likely to reoccupy the ground until the name and character of the former occupant had been forgotten. In the mean time the old foundation would have to be filled up to the general level, and for this purpose earth would have to be brought from another quarter. That the descendants should cling to the old mound of their forefathers is in accordance with all aboriginal tradition, and a home on such a mound, surrounded by neighbors, might well be regarded as a place of security and defense from attack. This latter idea probably determined all such cases of the selection of mounds for permanent residence in those times. The people of this particular locality were of the usual stature, and from all their properties and surroundings are judged to most resemble the Moquis and Pimos; certainly they must be classed with Pueblo tribes, and the quality of the pottery and its ornamentation point directly to the Indians just named as their descendants. Thus, with the unchanging pertinacity of the race, the same place if not the same spot was built upon, destroyed by fire, and rebuilt upon, the same mode of life, customs, manufactures, being continued for ages, until the want of food or water, some overwhelming epidemic or murderous raid of enemies, brought extinction to the little colony.

The posture observed in placing the deceased before burning the dwelling and contents is that noticed all along the western coast of North and South America: the knees were drawn up and the chin rested upon them; and no rule seems to have been observed in facing the individual, no one of the cardinal points being regarded more than another. Some of the specimens of food discovered near the skeletons are charred or decomposed, but still

bear distinctive marks by which they can be certainly determined, such as corn and pine nuts: and the traces of slowly evaporating water clearly indicate its former presence in the appropriate vessels, which were generally globular in shape with a narrow neck or contracted orifice. Household utensils for grinding corn or seeds, stone knives and implements for skinning and dressing animals for food and for use in converting the skin into leather, stone tips for arrows and heads for spears, stone awls or drills for making perforations, stone hammers, celts, axes, grooved stones for smoothing arrow shafts, stone disks, probably for gambling purposes, several flat stones such as are now used by kindred tribes for baking, a stone pipe for smoking tobacco or its substitute, and a very large number of sharp-pointed bone awls were obtained, such as are now in use by many tribes for puncturing holes in buckskin for sewing. They are remarkably well preserved and did not crumble on exposure; a result due probably to the previous elimination from the bone, by cooking, of all animal matter which might promote decomposition. No ornament or other object was found which could be referred to a European or other foreign origin. Some rough beads made of shell or bone were all, except that in one place a few small flat stone pendants of a greenish-blue color, perforated for stringing and made of the celebrated and rare turquoise or chalchiuitl, were found in connection with a skeleton probably of a chief, judging from the more than usual signs of opulence which surrounded him. These trinkets are obtainable only, so far as is now known, in one locality, namely, the Cerillos Mountains in New Mexico. Connected with these were pendants made of the iridescent pearly shell Haliotis, the nearest place for obtaining which is the shore of the Pacific Ocean.

In one stratum of ashes there were discovered some fragments of charred textile fabric, very coarse, but unmistakably twisted and plaited; hence we may infer that some other clothing was in use besides the buckskin garment. The fibres of which these are made could easily be obtained from an agave or a yucca, fibre-bearing plants, which abound in Utah and Arizona.

The series of objects obtained which forces itself most upon the attention was the collection of earthenware vessels, nearly fifty in number. The choicest lot was of seven pieces in connection with one skeleton, associated with some very neatly made arrowheads, a flat stone with serrated edge, the turquoise pendants above named, bone ornaments, stone drills, bone awls, red paint (for the face), and an exceedingly sharp knife of obsidian. Some of the

better forms and finer kinds of pottery were near children's skeletons. The form, color, and ornamentation of the ware is very various, and the latter is often elaborate. Some pieces were glazed, that is, if we are to understand by this term that the vessel has been coated over, after it is shaped in ordinary clay, with a finer earthy mixture, which fuses into a kind of glass, making a smooth reflecting surface. The addition of an outer coating of finer material upon which to impress some kind of ornament can be shown also in other instances from Utah and Arizona to be very ancient.

The pottery vessels when extricated from near the interior of the dwelling were entire and undefaced, but where they had been exposed near the edge or margin to moisture or influence of saline efflorescence they were cracked and the glazing had scaled off.

The quantity of broken pottery strewn around the environs is only a repetition of what may be found in wonderful profusion all over the adjoining Territories of Arizona and New Mexico. The quality of the ware, the shape, and the uniformly characteristic ornamentation declare unmistakably that the tribes which manufactured the articles are now represented by their descendants the Moquis, Pimos, and Maricopas living north of the Gila River and forming the tribes of Pueblos or settled Indians of that country. The immense quantity of this pottery may be well accounted for by remembering that in such an arid country the most urgent and never-ceasing demand was for water to allay thirst. To provide for this it was customary to arrange rows of ollas or water jars of large capacity, sinking them up to their necks in the sandy soil so as to check evaporation from the surface, and, when opportunity served, to fill them and thus keep a store of the precious fluid at hand. Something analogous is seen in the rows of capacious jars of similar ware which have been found embedded in the soil near the ruins of Nineveh, in the Isle of Cyprus, and on the site of ancient Troy. Oil or wine or water, all or either of them, may have been contained in the latter, but the fragments of pottery on these sites are also very numerous and similarly accounted for.

PROFESSOR TYNDALL'S EXPERIMENTS ON SPONTANEOUS GENERATION, AND DR. BASTIAN'S POSITION.[1]

BY REV. W. H. DALLINGER.

THE largest difficulty surrounding the question of the mode of origin of septic organisms is that of discovering their life-cycle. By dealing with them in aggregations we run told and untold risks. The conflict of results by this means, in the most accomplished hands, employing the most refined methods during the past eighteen years, is a sufficient witness. Repetitions of experiments, and conflicting results, and explanations of the reason why, and so the cycle rolls. Of course important lessons in biology are learned, but not *the* lesson. And yet by the teachings of this complex and doubtful method *alone* Dr. Bastian is content to accept "abiogenesis" as a great fact in nature.

To those who are best acquainted with the experimental history of the subject for the last twenty — but certainly for the six — years this is the more remarkable. For the weight of evidence is certainly not only *not* in favor of "abiogenesis," but is in the strongest sense adverse to it. The most refined, delicate, and continuous researches all point to the existence of what are at present ultra-microscopic germs. This, indeed, is directly affirmed by the authors. A single and recent instance will suffice. After a remarkable series of experiments detailed before the Royal Society, Dr. W. Roberts says: "The issue of the foregoing inquiry has been to confirm in the fullest manner the main propositions of the panspermic theory, and to establish the conclusion that *bacteria* and *torulæ*, when they do not proceed from visible parents like themselves, originate from invisible germs floating in the surrounding aërial and aqueous media."

But further, this has been remarkably sustained by analogical evidence. There are putrefactive organisms that closely approximate to the bacteria in form, structure, and size. These are the "*monads*," or, as Professor Huxley doubtless more fitly names them, the *Heteromita*. They live side by side with the bacteria in the same putrescent mass, and certainly in the later stages of the disintegration of dead organic matter are the most active and powerful agents. From their greater size they present a more promising field for microscopical research than the bacteria themselves; and the life-history of some of these could be fully mastered. I long since felt that valuable aid might thus

[1] Extracts from an article in Popular Science Review, London, April, 1876.

be rendered to the discovery of the nature of the bacteria. Armed with the best and most powerful appliances which the modern optician could supply, Dr. J. Drysdale and myself ventured on the work. The results are fully detailed elsewhere. It need only be remarked here that the only hope of success was in *continuous* observation of the same form, in the same drop of fluid under the highest powers. The secret, therefore, was to find a means of keeping the same drop under examination without evaporation. This we did. The result was that patient work enabled us to completely unravel the life-history of six of these organisms. These life-cycles cannot be here recounted. Suffice it now to say that each of them multiplied enormously by self-division (fission), but that the life-cycle in *each case* began and ended in *a distinct genetic product* — call them what we choose, spores, germs, or ova.

We have here, then, important indications of fact concerning the nearest allies of the bacteria: they develop from germs.

We have, besides, the weight of the best experimental evidence pointing clearly to the existence of germs in the bacteria themselves. But the microscope has failed to *demonstrate* the latter. Its finest powers and finest methods failed to reach them.

Happily at this juncture Professor Tyndall has stepped in, and with his accustomed brilliance and precision has opened up the path we need. *He has presented us with a physical demonstration of the existence of immeasurably minute molecules of matter — utterly beyond the reach of the most powerful combination of lenses yet constructed — which are the indispensable precursors of bacteria in sterilized infusions.*[1] In short, he has opened up a new and exact method, which must lead to a scientific determination of the existence and nature of the bacteria-germs. His beautiful experiments on the decomposition of vapors, and the formation of actinic clouds by light, led him to experiment on the floating matter of the air, and with what results is widely known. Confined and undisturbed air, however heavily charged with motes, becomes at length, by their deposition, absolutely clear, so that the path of the electric beam is invisible across it. From this, and associated indications, he acutely inferred "that the power of developing life by the air, and its power of scattering light would be found to go hand in hand;" so that a beam of light sent across the air into which infusions might be placed and examined by the eye, rendered sensitive by darkness, might

[1] Nature, January 27, 1876, page 252, and February 3, page 268.

be utilized with the best results in determining the existence of bacteria-germs. To bring the idea to a practical result a number of chambers were constructed with glass fronts. At two opposite sides facing each other a couple of panes of glass were placed to serve as windows, through which the electric beam might pass. A small door was placed behind, and an ingenious device was arranged to enable a germ-tight pipette to have free lateral, as well as vertical, motion. Connection with the outer air was preserved by means of two narrow tubes inserted air-tight into the top of the chamber. The tubes were bent several times up and down, "so as to intercept and retain the particles carried by such feeble currents as changes of temperature might cause to set in between the outer and the inner air."

Into the bottom of the boxes were fitted air-tight large test-tubes, intended to contain the liquid to be exposed to the action of the moteless air.

"On September 10th the first case of this kind was closed. The passage of a concentrated beam across it showed the air within it to be laden with floating matter. On the 13th it was again examined. Before the beam entered, and after it quitted the case, its track was vivid in the air, but within the case it vanished. Three days quite sufficed to cause all the floating matter to be deposited on the sides and bottom, where it was retained by a coating of glycerine, with which the interior surface of the case had been purposely varnished. The test-tubes were then filled through the pipette, boiled for five minutes in a bath of brine or oil, and abandoned to the action of the moteless air."

In this way the air in its normal condition was freely supplied to the infusions, but of mechanically suspended matter it could be demonstrated that there was none. And it was proved, with a clearness that admits of no quibble, that infusions of every kind, animal or vegetable, were absolutely free from putrefactive organisms. "In no single instance . . . . did the air which had been proved moteless by the searching beam show itself to possess the least power of producing bacterial life or the associated phenomena of putrefaction." But portions of the same infusions exposed to the common air of the Royal Institution Laboratory at a continuous temperature of from 60° to 70° Fahr. fell invariably into putrefaction; and when the tubes containing them amounted to 600 in number not one of them escaped infection — they were all "infallibly smitten." Here is irresistible evidence

that there is a direct relation between a mote-laden atmosphere and bacterial development. The whole series of Dr. Tyndall's exquisite experiments is simply an irrefragable affirmation of this truth. The presence of the physically demonstrated motes is as essential to the production, in a sterilized infusion of septic organisms, as light is to actinic action. They cannot be made to appear without the precursive motes; they cannot be prevented from appearing if the motes be there. That these are the germs of bacteria by themselves, or associated with minute specks of matter, approximates to certainty in the proportion of hundreds of millions to one.

A beautiful illustration of the minuteness and multitude of the particles is given. Let clean gum mastic be dissolved in alcohol, and drop it into water; the mastic is precipitated and milkiness is produced. Gradually dilute the alcoholic solution, and a point is reached where the milkiness disappears, and by reflected light the liquid is of a bright cerulean hue. "It is in point of fact the color of the sky, and is due to a similar cause — namely, the scattering of light by particles small in comparison to the size of the waves of light."

Examine this liquid with the highest microscopical power, and it appears as optically clear as distilled water. The mastic particles are almost infinite in number, and must crowd the entire field of the microscope; but they are as absolutely ultra-microscopic as though they had no existence. I have tested this with an exquisite $\frac{1}{50}$ of Powell and Lealand's, employed with a new and delicate mode of illumination for high powers,[1] and worked up to 15,000 diameters; but not the ghostliest semblance of such particles was seen. But at right angles to a luminous beam passing among these particles in the fluid "they discharge perfectly polarized light." "The optical deportment of the floating matter of the air proves it to be composed, in part, of particles of this excessively minute character," and it is among the finest of these ultra-microscopical particles that Professor Tyndall finds the sources of bacterial life. It is almost impossible to conceive a nearer approach to certainty concerning the nature of these minute particles than this. Their minuteness, their capability of being physically demonstrated, the absolute necessity of their presence to the origination of bacteria in sterilized infusions of any and every kind, taken in connection with what we *know* concerning the germs of the *Heteromita* whose life-histories have

[1] Monthly Microscopical Journal, April, 1876.

been studied, render it simply inevitable that we have at length reached, what we are justified in believing to be, a genetic product of the bacteria through which their continuation as organisms is preserved. When first I saw the simplicity and beauty of this method, it struck me that its applicability as a test in reference to germs — *known to be such* — would have considerable collateral weight; and a method of employing it was suggested by a fact in past experience.[1] I had in my possession a maceration of cod's head, which I had kept in use for eleven months. It had become a pulpy mass, and in the middle of January last it was comparatively free from bacteria, but swarmed with two monads — the fourth and sixth of the series described by my colleague and myself. To ascertain their exact condition, I watched them on the "continuous stage" for three consecutive days, and found that both forms were to be seen plentifully emitting spore. The maceration had become very short of moisture, which served my purpose. I subjected it to a dryer air with a higher temperature, and it was not very long in becoming a moist pulpy mass, with sufficient cohesiveness to be removed from the vessel; and in this condition it was placed in a heating chamber, which was slowly raised to a temperature of 150° Fahr., and kept at this for an hour. This was 10° Fahr. higher than Dr. Drysdale and myself had proved necessary to destroy absolutely every adult form. The baked mass now appeared cracked, porous, and flaky. In parts it was extremely friable, and with little pressure crumbled into almost impalpable powder; while by friction a very large proportion was reduced to the finest dust. To avoid all possibility of error this powder was again exposed in the heating chamber, spread over a plate of glass, to a temperature of 140° Fahr. for ten minutes — thus rendering the plea of mere desiccation impossible.

A chamber or box was now prepared precisely like Professor Tyndall's, except that there were no tubes to communicate with the outer air.

In the Researches on the Life-History of Monads we had proved that they could live, thrive, and multiply almost as well in Cohn's "nutritive fluid" as in the normal animal infusion. This fluid is composed of phosphate of potash, sulphate of magnesia, triple basic phosphate of lime, tartrate of ammonia, and distilled water. If these ingredients are all mingled the fluid becomes speedily charged with bacteria, unless hermetically

[1] Monthly Microscopical Journal, xii. 262, 263.

sealed, and sometimes even then. We therefore keep the ammonia in a separate solution, mixing them when required.

A portion of the fine dust of the maceration was now taken and thoroughly scattered through the air of the prepared chamber. The condensed beam from an oxyhydrogen lime-light[1] was then sent through it. Its line of passage was far more brilliantly marked inside the chamber than in the outer air. It was deemed inexpedient to insert the fluids while such brilliant points were visible in the air, and four hours were suffered to elapse. The lime-light beam was still visible with perfect distinctness, but its path within the chamber was much less brilliant and more homogeneous than it was without. The fluids were then carefully mixed, and five small glass basins of the mixture were inserted. The whole was undisturbed for five days. At the expiration of that time the beam of the lime-light sent through the chamber was absolutely invisible, although perfectly clear in the open air on both sides of it.

The fluids were now withdrawn. Ten "dips" were taken out of each basin for microscopical examination. *In every "dip"* — that is, fifty in all — *one or other of the monads appeared, and were in a state of active fission;* and in twenty-seven of the "dips" both monads were found. Bacteria swarmed the field, which of course I fully expected.

I now took five *other* glass vessels, and inserted them with great care into the now moteless air of the chamber, and poured in, as before, fresh Cohn's fluid. They were exposed for another five days. On careful microscopical examination of seventy-five "dips" *not a single monad of either form appeared;* bacteria were feebly present, but of course no steps were taken to guard against these, and, as before, they were anticipated.

The air of the chamber was again impregnated with dust, as before, suffered for a time to settle, and *these same vessels of fluid*, which had yielded negative results, were again placed in the chamber. At the expiration of five days they were again examined, *and one or other of the monads was found in every successive "dip."*

Now let it be observed that there can be no possible error as to the forms. They were the identical species of the maceration, with which I am as familiar as with a barn-door fowl. What, then, is the logic of these facts? Dr. Tyndall proves that bac-

[1] This was of course very much less capable of "searching" than the electric beam; but it served for the rougher end I had in view.

teria only develop in sterilized infusions when the air around them is laden with motes of incalculable multitude and exquisite minuteness. Given the presence of these, and the development of bacteria is inevitable. The inference is that the motes are *germs*. The above experiments show, that in closely allied septic organisms, the germs of which have been demonstrated and their developments watched, if the dry *débris* of a maceration in which these forms are found be scattered in the air around a prepared fluid, and demonstrated by similar optical means, that the said organisms develop; but if the minute dust from the *débris* be optically proved to be *absent*, none of the monad forms appear. Here we do not hypothecate a germ, but we *know* that it exists; and its deportment in similar conditions is identical with that of the assumed bacterial germ. Do we need more irresistible evidence that the bacteria develop, not *de novo*, but from genetic products?

Now, until Dr. Bastian's promised "new results"[1] have appeared, I believe I am justified in affirming that the strongest cases on which even he relies for "spontaneous generation" are recorded on pages 175, 180, of his Evolution and the Origin of Life. They are thus introduced: "After this I may, perhaps, be deemed fully justified in quoting two *very typical* experiments for the further consideration of those who stave off the belief in spontaneous generation — either by relying on the insufficient reasons for doubting the influence of boiling water, or because of their following Pasteur, Cohn, and others in supposing that certain peculiar bacteria germs are not killed except by a brief exposure to a heat of 227° or 230° F. For even if we could grant them these limits, of what avail would the concession be . . . . in the face of the following experiments?" The details of the experiments follow. They are alike in method, and we will concern ourselves only with the second. A strong infusion of common cress, with a few of the leaves and stalks of the plants, were inclosed in a flask, which was hermetically sealed while the fluid within was boiling. It was then introduced into a digester and gradually heated, and afterwards kept at a temperature of 270–275° F. for twenty minutes, and was retained at a temperature, if the time of heating and cooling be considered, over 230° F. for one hour. This flask was opened after nine weeks. The reaction was acid; the odor was not striking. On microscopical examination with a $\frac{1}{12}$ inch objective "*there appeared more than a dozen very active monads.*"

[1] Times, January 29, 1876.

Now, fortunately, Dr. Bastian has not only carefully measured and described these organisms, but he has drawn them, and they are reproduced on the frontispiece of the book. He describes them as the $\frac{1}{4000}$ of an inch in diameter; they were provided with a long, rapidly moving lash (flagellum), by which granules were freely moved about. But, besides this, "*there were many smaller, motionless, tailless spherules, of different sizes, whose body-substances presented a similar appearance to that of the monads*, and of which they were in all probability earlier developmental forms."[1]

Now, by careful comparison, I find that this monad is no other than the "uniflagellate monad," which is the fourth in the series whose life-histories were studied by Dr. Drysdale and myself.[2]

(1.) Dr. Tyndall has proved, in connection with a host of others, but in a more definite and precise manner, that in *filtered infusions* five minutes' boiling does kill every form of bacteria.

(2.) He has further shown that they are propagated by demonstrable germs *only*, in such infusions; and

(3.) This fact removes the probability of their spontaneous generation to an almost infinite distance.

As to the development of bacteria in infusions charged with solid matter, precise experiment of a sufficiently comprehensive character has yet to be made on them, in relation to the demonstrated germs. Meantime, shall we accept "spontaneous generation" on such ground as its strongest advocate has now to offer, and ignore the vast chain of facts copiously attested and controlled, which are in perfect harmony with the known laws of the entire organic world? This, and nothing less than this, is what Dr. Bastian inculcates and demands.

RECENT LITERATURE.

PICKERING'S ELEMENTS OF PHYSICAL MANIPULATION.[3] — The first volume of this useful manual we noticed at the time it was published; the second, now before us, is more extended in its range than originally intended by the author, and will be still more valuable for students. This volume treats of electricity, heat, mechanical engineering, meteorology, practical astronomy, and lantern projections. The author suggests

[1] Evolution, page 178.

[2] Monthly Microscopical Journal, xi. 69, *et seq.*

[3] *Elements of Physical Manipulation.* By PROF. E. C. PICKERING. Part II. New York: Hurd and Houghton; Boston: H. O. Houghton & Co. 1876. 8vo, pp. 316. $4.00.

that the laboratory method may be used to teach astronomy as successfully as chemistry or physics; and accordingly considerable space is given to this subject, sufficient instructions being given to enable the civil engineer or explorer to be able to determine his latitude, longitude, and time, by the sextant or transit. The chapter on lantern projections will be found useful to lecturers on scientific topics, who need the lantern as a means of illustration, and to know how to produce the best results by simple and inexpensive means.

HAYDEN'S REPORT ON THE GEOLOGY OF COLORADO.[1] — This report is almost entirely devoted to geology, comprising the observations made by Professor Hayden and his assistants in 1874. The volume is mainly filled with the reports of Professor Hayden, Dr. A. C. Peale, and Mr. F. M. Endlich. Dr. Samuel Aughey contributes a valuable chapter on the surface geology of Nebraska, and Mr. L. Lesquereux a report on the Tertiary flora of the North American Lignitic, considered as evidence of the age of the formation, with a review of the cretaceous flora of North America; an extended and very fully illustrated report on the ancient ruins in Southwestern Colorado, by Mr. W. H. Jackson, is followed by an interesting essay on the molluscs of the Rocky Mountains, by Mr. Ernest Ingersoll, illustrated by some anatomical drawings. Under the head of Topography and Geography, are reports by Messrs. Henry Gannett, S. B. Ladd, A. D. Wilson, and Franklin Rhoda. The volume is certainly in interest and practical value not behind its predecessors.

BAIRD'S ANNUAL RECORD OF SCIENCE FOR 1875.[2] — This volume will be found indispensable to the general public, and of value to the special student who may want a popular summary of discoveries in all departments of science. We think that the present Record is more valuable than its predecessors, from the greater space (272 pages) devoted to the General Summary of Progress. Appended is a list of some of the more prominent scientific publications published during 1875. The full index gives evidence of careful editing. The present volume is a still more useful register of progress than the others of the series, and giving as it does a fair proportion of space to American discoveries, deserves the widest circulation.

RECENT MEMOIRS ON NORTH AMERICAN MAMMALS. — Dr. Gill's Synopsis of Insectivorous Mammals[3] is not by any means limited to the

[1] *Annual Report of the United States Geological and Geographical Survey of the Territories, embracing Colorado, and parts of Adjacent Territories; being a Report of Progress of the Exploration for the Year* 1874. By F. V. HAYDEN. Washington. 1876. 8vo, pp. 515. With numerous illustrations.

[2] *Annual Record of Science and Industry for* 1875. Edited by S. F. BAIRD, with the assistance of eminent men of science. New York: Harper and Brothers. 1876. 12mo, pp. 656.

[3] *Synopsis of Insectivorous Mammals.* By THEODORE GILL. Bulletin of the United States Geological and Geographical Survey of the Territories. No. 2 (pp. 92–124). Second Series. Washington: Government Printing Office. May 14, 1875.

Insectivora of North America, as it was undertaken partly in continuation of his Arrangement of the Families of Mammals and "partly for a general work on the mammals of North America," and hence discusses the characters and mutual affinities of the insectivorous mammals of the whole world. To those who are already familiar with Dr. Gill's former excellent work in this line, it will be sufficient to say that it is a work of the same thorough character as his former essay on the *Educabilia*, published in 1872.[1] He gives first a general history of the subject, which includes a critical notice of the views of the different systematic writers who have given these animals special attention, beginning with Cuvier, who in 1816 first combined them into a single distinctive group, down to the recent mature classification of Professor St. George Mivart, first published in 1867 and revised in 1872. The schemes of classification of the leading authorities are quoted *in extenso*, and the gradual progress noted from Gray's crude and fanciful combinations (1823–1843), and the later more natural ones of Gervais (1854) and Wagner (1855), to the more highly improved schemes of Peters (1864), Mivart, and Gill (1872); while the retrograde system proposed by Fitzinger (1867–1869) receives the unfavorable criticism it so well deserves. Gill, in 1872 and in the present memoir, agrees essentially with Mivart in respect to the number and constitution of the families, but differs from him somewhat in respect to their order of sequence and combinations.

Wagner, in 1855, first referred the peculiar genus *Galeopithecus* to the Insectivora, which genus had previously been associated with the lemurs by some writers, with the bats by others, and by others regarded as an isolated type. This recognition of its affinities was subsequently adopted by Peters, and later met with the approval of Mivart and our present author.

The *Insectivora* constitute the sixth order of mammals in Dr. Gill's scheme of classification, which order he subdivides into two suborders, the *Dermoptera*, consisting of the *Galeopithecidæ*, or so-called "flying lemurs," and the *Insectivora vera*, including all the other families. These are the *Talpidæ* and *Soricidæ* (combined into a "superfamily *Soricoidea*); the *Erinaceidæ* (= superfamily *Erinaceoidea*; the *Centetidæ* and *Potamogalidæ* (= superfamily *Centetoidea*); the *Chrysochloridæ* (= superfamily *Chrysochloroidea*); the *Macrocelididæ* and *Tupayidæ*; (= superfamily *Macrocelidoidea*). An extinct family *Leptictidea* (American), is also recognized. The order, suborders, families, and subfamilies, are each elaborately diagnosed. A list of the genera with their synonymy is also appended as well as a list of the monographic essays treating of the different groups, with also some remarks on "Range of Varia-

[1] *Arrangement of the Families of Mammals. With Analytical Tables, prepared for the Smithsonian Institution.* By THEODORE GILL, M. D., Ph. D. Washington: Published by the Smithsonian Institution, November, 1872. 8vo, pp. vi. 98. (Smithsonian Miscellaneous Collections, 230.)

tion," with a "genealogical tree," and remarks on the "Geographical Relations of the American species." Finally is added an "Appendix" respecting the American species, in which is given a table of the contrasted characters of the *Soricidæ* and *Talpidæ* — the only American families — with a synoptical list of the general works and special papers that relate to them.

The foregoing imperfect synopsis of Dr. Gill's excellent memoir is sufficient to show that it is a paper of very great importance to students of American mammalogy.

Quarterly Bulletin of the Nuttall Ornithological Club.[1] The first number of this new ornithological journal appears with an excellent steel engraving of a new species of *Helminthophaga*, from a drawing made by Mr. Robert Ridgway. The nine articles are by Messrs. W. Brewster, C. J. Maynard, J. Warren, W. Van Fleet, C. M. Jones, H. W. Henshaw, and R. Deane. The number is well printed and is creditable to the club.

Recent Books and Pamphlets. — Elements of Physical Manipulation. By Edward C. Pickering. Part II. New York: Hurd and Houghton; Boston: H. O. Houghton & Co. 1876. 8vo, pp. 316. $4.00.

Eighth Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri. Jefferson City. 1876. 8vo, pp. 185.

Life of Israel Putnam. By Increase N. Tarbox. With maps and illustrations. Boston: Lockwood, Brooks, & Co. 1876. 8vo, pp. 389. $2.50.

Working People and their Employers. By Washington Gladden. Boston: Lockwood, Brooks, & Co. 1876. 12mo, pp. 241. $1.75.

Words; their Use and Abuse. By William Mathews, LL. D. Chicago: S. C. Griggs & Co. 1876. 12mo, pp. 384. $2.00. For sale by Lee and Shepard, Boston.

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Is Nature Inconsistent? By B. G. Wilder. (From the Galaxy.) New York 1876. 8vo, pp. 10.

[1] Published by the Club, at $1.00 a year; single numbers, 30 cents. Address H. B. Bailey, 13 Exchange Place, Boston, Mass. 8vo, pp. 28.

The Mollusks of the Rocky Mountains. By E. Ingersoll. (From Popular Science Monthly, May, 1876.) 8vo, pp. 7.

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On the Occurrence of Eozoön Canadense at Côte St. Pierre. (From the Quarterly Journal of the Geological Society for February, 1876.) London. 8vo, pp. 10, with a plate.

GENERAL NOTES.

BOTANY.[1]

Schœnolirion *Torr.* — This is the name given by Dr. Torrey to an Asphodelineous, Liliaceous genus, founded on *Phalangium croceum* of Michaux, a native of Georgia. Elliott, having what he supposed to be Michaux's plant, transferred it to *Ornithogalum*, and described the petals as white, with a mark of doubt. Later, Scheele, in *Linnæa*, xxiii. 146, published an *Ornithogalum Texanum* with white flowers, from Lindheimer's Texan collection. In the Botany of the Mexican Boundary Survey, issued in 1859, Dr. Torrey characterized the present genus and a species, *S. Michauxii*, referring to it Michaux's original plant "floribus croceis," the plant which Elliott had taken for it, and which was now known, from Florida specimens collected by Mr. Buckley and Dr. Chapman, to be white-flowered, and likewise the Texan plant which was equally white-flowered. The blossoms of these sometimes turning yellowish in drying, Dr. Torrey too hastily concluded that Richard, the editor of Michaux's Flora, had mistaken such originally white flowers for saffron-colored, and so changed the specific name in order to correct an error while he honored the discoverer. Dr. Chapman, in his Southern Flora, adopted Dr. Torrey's view, he knowing of a white-flowered

[1] Conducted by Prof. G. L. Goodale.

species of his district; but he long ago expressed to us the opinion that this could hardly be Michaux's original species. Dr. Wm. T. Feay, of Savannah, several years ago had the good fortune to meet with the original yellow-flowered species, and the acuteness to mark the distinctions. But only this spring was he able to procure fresh specimens, and to place them in my hands for confirmation. My attention being thus called to this genus, it was not difficult to ascertain that my lamented associate had brought together, under his name of *S. Michauxii*, three nearly related but distinct species. This does not include still another plant, of which a flowering raceme only, collected by Mr. Pratten in California, had been submitted to him by Mr. Durand, and which, at his suggestion, was published in Durand's *Plantæ Prattenianæ* under the name of *Schœnolirion album*. I know nothing of this Californian species, and it certainly needs confirmation. I can, however, perfectly identify the original species. When examining the Michauxian herbarium at the Jardin des Plantes, in 1839, I could find no specimen of this rare "*Phalangium croceum*." I sought and found it, however, in the herbarium of L. C. Richard, the editor of Michaux; and the possessor, Achille Richard, kindly permitted me to take a capsule and a couple of flowers, which, with my notes, are still preserved. Now that we know there is a yellow-flowered species, I cannot doubt that this is Michaux's plant, and it inhabits a district which he repeatedly traversed. Moreover it is also well described by Nuttall (Gen. Pl. i. 220), who distinctly states that the flower is "saffron-yellow," a statement which Dr. Torrey must have overlooked. The species may be distinguished by the following brief diagnosis: —

(1.) S. CROCEUM. Flowers saffron-yellow; divisions of the perianth oblong, 3-nerved; filaments nearly filiform; leaves (arid, gramineous, *Nutt.*) narrow and tougher than in the following, *Phalangium croceum*, Michx. Fl. i. 196; Nutt. Gen. i. 220. Southwestern part of Georgia, Michaux, Feay, etc.

(2.) S. ELLIOTTII *Feay*. Flowers white; divisions of the perianth oval, mostly 5-nerved; filaments subulate. *Ornithogalum croceum*, Ell. Sk. i. 397, excl. syn. *Schœnolirion croceum*, Torr. quoad syn. Ell.; Chapm. Fl. 483. S. Georgia and Florida.

(3.) S. TEXANUM. Flowers white; divisions of the perianth oblong, 3-nerved; filaments subulate. *Ornithogalum Texanum*, Scheele in *Linnæa*, xxiii. 146. *Schœnolirion Michauxii*, Torr. Bot. Mex. Bound. 220, excl. syn. Michx. and Ell. E. Texas, and adjacent borders of Louisiana.

S. ALBUM. Durand, Pl. Pratt in Jour. Acad. Philad. n. ser. iii. 103, of California, needs confirmation. — ASA GRAY.

ANTHERS IN TRILLIUM. — These are described, and on the whole correctly, as introrse in *Trillium*, while they are extrorse in *Paris*, and in the Himalayan *Trillidium*, which is between the two. The species vary some, such as *T. cernuum*, having an almost marginal dehiscence.

And Mr. M. W. Vansdenberg, of Fort Edward Academy, New York, an acute correspondent, has pointed out a marked exception in the case of *Trillium erythrocarpum*. This has the most slender filaments of all, and my correspondent calls attention to the fact that they are inserted on the divisions of the perianth, well above their base, and the anthers are plainly extrorse. — Asa Gray.

Spores of Blodgettia confervoides. — In Harvey's Nereis Am. Bor. there is a curious figure of a plant which he called *Blodgettia confervoides*, which, if it correctly represents the fructification of the alga in question, is entirely unlike that of any other known alga. Bornet is of the opinion, from examining dried specimens, that the bodies figured as spores are parasites of some kind. Mr. F. W. Hooper, recently returned from Key West, gives the following as the result of his examination of living specimens of Blodgettia :—

"The figure of Harvey is curious indeed. To begin with the curious net-work of fibres bearing his so-called spores is, together with the spores, entirely colorless. The anastomosing fibres are made up of short cells placed end to end. The cells are about three times as long as broad. The wall of the cell is distinct and the contents colorless. It would seem, in many cases, that the so-called spores are only thin cellules swollen up, since they appear often in the middle of a filament. They are more often borne on a side branch and are often irregularly placed, looking like a miniature bunch of grapes. This whole structure is not a part of the cell-wall, but ramifies between the layers of the cell-wall. As a proof of this we have this peculiar arrangement of fibres and spores (?) continuing right through from one cell of the Blodgettia to the next. I am certain that the filaments and spores (?) have walls distinct from the layers of the cell-wall of the Blodgettia. A cross section shows this distinctly. Generally two or three layers of the cell-wall of Blodgettia separate the parasite (?) from the cavity of the cell. I can see but little reason for calling it a unicellular alga. Morphologically it suggests those Callithamnia which have seirospores." — W. G. Farlow.

Botanical Papers in Recent Periodicals. — *Bulletin of the Torrey Botanical Club*, May. T. L. Brandegee, List of Colorado Musci and Hepaticæ. P. J. Berckmans, in answer to a query by Dr. Thurber, states that *Acanthospermum xanthoides* and *Clerodendron Siphonanthus* were observed by him (in 1857 and 1873 respectively) in Georgia. Professor Tuckerman states that Willdenow's description of *Phaseolus multiflorus* was founded upon Cornuti's plant.

Annales des Sciences Naturelles, Botanique, VI. Sér., II. Tome, Nr. 2 et 3. P. Duchartre, Observations on the Bulbs of Lilies (2d memoir). Ch. Naudin, Irregular Variation in Hybrid Plants. Vesque, Comparative Anatomy of Bark.

Comptes Rendus, 1876, No. 14. M. Cornu, On the Spermatia of Ascomycetes, their Nature and their Physiological Role. No. 15. Boussingault,

The Growth of Maize begun in an Atmosphere free from Carbonic Acid. Schnetzler, Action of Sulphide of Carbon on the Insects infesting Herbaria. No. 16. A. Trécul, On the Capillary Theory, illustrated by Amaryllidaceæ.

Flora, No. 10. Georg Winter, On some Ustilagineæ. Kraus, On the Formation of Hairs on Potato Sprouts. Geheeb, Mosses from the Mountains near the Rhone. De Krempelhuber, Brazilian Lichens. Velten, The Influence of Temperature on Protoplasmic Movements (to be hereafter noticed). Ranwenhoff, Is Horny Prosenchyma a Special Vegetable Tissue? (Answered in the negative.)

Botanische Zeitung, No. 15. Weisner, On the Crystalline Character of the Waxy Deposit on Cuticle. Brefeld, On the Culture of certain Fungi. No. 16. Holle, On the Growth of Roots of Angiospermous Plants, with Special Reference to the Root-Cap. No. 17. Sadebeck, On the Relation of Pythium Equiseti to the Potato Fungus. No. 18. Velten, On Electricity in Plants.

ZOÖLOGY.

Another Case of Animal Commensalism. — An interesting instance of animal commensalism came to my notice recently, during the cruise of the United States ship Portsmouth among the islands of the Pacific Ocean. I found in the cloacal dilatation of the alimentary canal of a holothurian a crab belonging to a class higher in the scale of classification than any that has yet been discovered possessing parasitical habits.

It is the first instance to my knowledge where a crustacean of the high type Cancroideæ has been found living as a "free messmate" within the body of another animal. It belongs to the family Portunidæ, or swimming crabs; and it is one of those aberrant forms, or connecting links, uniting the natatorial and the gressorial species.

It represents not only a new species, but a new genus; and Dana unconsciously possessed the type of the genus in a little individual which he found on the coral reef at Ovolan, Feejee Islands. He modified an already existing genus (*Lissocarcinus* White) in order that it might receive his species; yet, in spite of his modification there exists almost as wide a difference between the two as between two common genera of our own coast, *Carcinus* and *Platyonichus*, which are related in the same way. White, in the description of his species (*Lissocarcinus polyboides*), states that it is a powerful swimmer, with the tarsi of the posterior pair of feet broadly expanded; while in Dana's species the tarsi are flattened and expanded in about the same proportion as in *Carcinus*, a littoral genus, where the lateral expansion of the tarsus of the last pair scarcely exceeds that of the three preceding pairs.

Dana's species was a male; while the one which I found was a female. It is well known that among crustaceans it is generally the fe-

males that seek these strange places of abode, while the males live a free and roving existence; and as the general shape of the body is somewhat different in the two sexes under these circumstances, it is possible that Dana's species is the male form of the one which I discovered. In the latter the carapace or shield is less orbicular, and more produced transversely; while the shape of the claws and ambulatory feet, as well as the peculiar markings on each, are almost identical.

I propose for this little individual the suggestive generic title *Assecla*; the specific name *holothuricola* will indicate her odd place of abode. The habitat is Palmyra Island, one of the Fanning group. Dana's species belongs in the same genus under the name of *Assecla orbiculare*, unless further research should determine it to belong to the same species. — Dr. Thomas H. Streets, U. S. N.

The Little White Egret in Colorado. — In Birds of the Northwest, Dr. Coues states that "the introduction of *Ardea candidissima* Gm." among the birds of the region drained by the Missouri and its tributaries "rests on its occurrence in Kansas, as recorded by Professor Snow." A specimen in fine plumage was killed and presented to me last week (May 4th), by Mr. James Sevar, of this place. It was taken on the shores of a small "lake," near the eastern base of the mountains, thirty miles northwest of Denver. The bird was a "lonely pilgrim," and had wandered far from its maritime home. — J. Clarence Hersey, Boulder, Colorado.

Sensitiveness to Sound in the Shrew. — In the heavily-timbered forest in the neighborhood of Sheboygan, Michigan, on a cold day in October, 1875, I caught a characteristic full-grown specimen of Thompson's shrew (*Sorex Thompsonii* Baird). The pretty little creature had been busy about an old decayed stump, where it seemed to have its home. It uttered no audible cry, though at first it made several hostile demonstrations, endeavoring to escape, and, seizing my fingers in its mouth tried to bite them, but the delicacy of its teeth rendered the attempt futile. Having no suitable place in which to deposit it, I carefully wrapped it in paper, allowing its head to protrude, and held it in my hand. Some sportsmen were out shooting on the bay about a mile off, and the reports from their guns came to us from time to time, generally so much muffled by the distance as to be barely distinguishable, yet the shrew invariably responded to each detonation with a quick, spasmodic movement, evidently of alarm. Holding the animal as I did, the movement was immediately perceptible. Though aware that the acuteness of the auditory organs of these animals and their allied genera is most wonderful, I was hardly prepared for so unequivocal a proof of its extreme sensitiveness, which, under the circumstances, I was enabled to test repeatedly in this individual *Sorex*.

It was my intention to preserve the animal alive, and take it with me on my return home for further experiment and a study of its habits;

but, to my regret, on unfolding the paper while on my way to the house at which I was staying, I found the shrew had died. I have little doubt but that its death was caused by fright, as I handled it most carefully so as not to hurt it.

I found nothing of the unpleasant odor which is said to be secreted by certain glands with which this animal is provided, and which, in the form of a decided muskiness, is so apparent in the star-nosed mole. The shrew had, however, voided a slight quantity of excrement, which act, I believe, *in articulo mortis*, is common to all animals, including man. — HENRY GILLMAN.

ANTHROPOLOGY.

WESTERN WORKED FLAKES AND NEW JERSEY RUDE IMPLEMENTS. — Capt. Wm. A. Jones's Reconnaissance of Northwestern Wyoming having been received after the proof-sheets of my paper in the June NATURALIST were corrected and returned, I could not avail myself of the very interesting remarks of Professor Comstock on the archæology of that region, which in part refer to specimens such as I have described and figured in the article referred to. The implements described by Professor Comstock (Figures 40 and 41, p. 260) are evidently identical with that figured on page 331 of the NATURALIST (vol. x.). Of these western specimens Professor Comstock remarks, "It is scarcely to be supposed that these rude splinters have ever subserved the purpose of weapons or other implements, although there are many of the flakes of more definite shapes which may have been so employed. It seems probable, however, that a large proportion of those which can be referred to no particular form are merely the rejected pieces which have been spoiled during the process of manufacturing more perfect implements, or, in some cases, perhaps they are pieces from which smaller arrow-heads have been chipped." I cannot think that these specimens, at least such as those figured, are rejected or spoiled implements. The fact that the same forms occur in New Jersey, associated with others of scarcely more definite shape, and *not associated* with "smaller arrow-heads," is evidence, I claim, of their being finished implements. Again, if "failures," is it probable that there would be that uniformity in shape and size, which obtains among them? Thirdly, their outline suggests no other form of implement, such as we know; as "blocked-out" javelin heads, axes, and hatchets are well-known shapes to the collectors.

The similarity of the western specimens to fragments of rock, undoubtedly naturally formed, has suggested the possibility of all being of natural and not artificial origin. That a fragment of rock, accidentally produced, should be nearly or quite identical in outline with certain well-known forms of Indian relics, is quite natural, inasmuch as happily shaped pieces of flinty stone were the first tools used by primitive man, and suggested, in the course of centuries, the variations in shape which the increasing number and character of their wants demanded. The

oldest stone implements would therefore bear most resemblance to broken pebbles, and considering the fact, that in New Jersey this western form is quite common, and so found as to place its artificial origin beyond doubt, it becomes highly probable, if not certain, that the specimens figured by Professor Comstock are traces of the former occupants of Wyoming Territory, and that, *just as they are*, they subserved some purpose as a weapon or domestic implement.

Of their antiquity I can form no opinion; but as already stated in this journal, those found in New Jersey belong to a far-distant past, and are doubtless traces of a people antedating the red man. — CHARLES C. ABBOTT, M. D.

WERE THE OLDEST AMERICAN PEOPLE ESKIMOS? — In regard to Dr. Abbott's paper in the June NATURALIST, in which the ground is taken that the Eskimos represent an older North American man, whom "intrusive" Indians have driven northward and replaced, the following considerations suggest themselves. This view is doubtless inspired by the efforts of anthropologists in Europe to identify boreal races like the Lapps with the pre-Aryan population of Europe. Virchow concludes that no group of older skulls yet found can be said to agree with any of the living boreal types of man. The argument rests on the character of the stone implements. Dr. Abbott seems to rely for support to the theory he adopts on the "similarity of the Delaware Valley implements to those of Europe." But there is likely to be a similarity in implements between different races, at the same stage of culture. The view that the Lapps have suffered race-degradation is interesting, if it can explain the difference existing between the older European skull and that of the modern Lapp. But although the Lapps are possibly degraded Finns, the explanation is not offered to explain the wider relationship of the boreal types existing with the older European man. So far as the implements are concerned they are then not of themselves sufficient to sustain Dr. Abbott's theory with regard to the Eskimos. The evidence from tradition, appealed to by Dr. Abbott, is hardly to be trusted. Perhaps no traditions as a class are more untrustworthy than those of the North American Indians. They had not acquired the faculty of recollecting, one may almost say. I do not think it is safe to say that it has been "demonstrated conclusively that some eighty thousand years ago the last glacial epoch came to a close," but, even so, is it safe to rely upon a tradition which refers back to an event which must have happened during a remote epoch? The question remains, Where did the intrusive Indians come from? And in regard to man do we not find first, that it is, as a rule, unsafe to speak of "autochthones," and that there has been replacement everywhere? At whatever point man may have originated, he has spread from causes acting on himself from without, such as those dependent on climate and food, and then from causes arising from his advance in intelligence; these latter movements may be

called culture-migrations. Granting that the Indian replaced the older man who lived at the foot of the glacier, and that this older man is represented by the existing Eskimo, the consideration I have presented in a paper read (August, 1875) before the American Association,[1] that the migration of the Eskimos depended upon the climate of the post-glacial epoch, that they followed the ice as naturally as the butterflies and the reindeer, does not seem to me to be as yet invalidated. — A. R. GROTE.

ANTHROPOLOGICAL NEWS. — Among a large collection of Pai-Ute material received from Major J. W. Powell, at the National Museum, embracing specimens of their food, furniture of the dwelling, vessels and utensils, clothing, personal ornaments, implements, weapons, means of locomotion, pastimes, art, music, objects connected with social, civil, and religious life, some of the forms are new. A knife is of a hard, black volcanic stone, polished over its surface; the edge is beveled on both sides, and there are convenient notches for the fingers and thumb. A double bottle is similar to Peruvian forms, and there is quite a variety of these in the collection. A new method of hafting, which I have not seen figured, occurs in the case of nine axes and hammers. The head is the smooth, grooved variety, some of them having the groove all around, and others on three sides. In all cases the haft lies along one side, like a yoke on the neck of an ox, and the sinew or leather thong is *belayed* back and forward, around both haft and ax.

Near St. Georges, Southern Utah, on the Santa Clara River, Dr. Edward Palmer examined a mound about ten feet high, oval in form, and containing about half an acre. The mound seems to have been built up as follows: The former inhabitants constructed small dwellings of sticks, or sticks and stones, with mud roofs. When one of their number died, his remains, together with his apparel, implements, arms, ornaments, and vessels of food and water, were fastened up with him, and the whole consumed by fire. This is proved by the occurrence, irregularly throughout the entire mound, of strata of ashes in the exact shape of the ground plan of the house, and in the ashes the skeleton and objects deposited with the corpse. The fire-place in all can be located by a deeper layer of ashes. Subsequently earth was brought and leveled over the spot on which a new edifice was to be erected. Thus the process of accumulation went on, similar to what is exhibited on a grander scale in the city of Jerusalem and other old cities of the East.

We have a continuation of the labors of Abbé Petitot among the McKenzies River tribes in Dictionnaire de la Langue Déné Dindjie dialectes Montagnais ou Chippewayan, Peaux de Lievre, et Louchaux. Bibliothèque de Linguistique et d'Ethnographie Américaines. Publié par Alph. L. Pinart.

The Smithsonian Institution has received for publication an illustrated article upon the prehistoric mounds of Grant County, Wisconsin, by

[1] American Journal of Science and Arts, p. 338.

Moses Strong, Assistant State Geologist. These investigations cover a portion of the State to which very little space is given in the great work of Lapham in the Smithsonian Contributions.

An event of considerable interest to anthropologists was the sale of Hon. E. G. Squier's entire library and collection of archæological specimens, on the 24th of April last.

The Archives de la Société Américaine de France, has come to hand, a pamphlet of four hundred pages, containing, in addition to the journal, etc., of the society, treatises upon the Eskimo, the Indians of the Great Interior Basin, the Californians, the Mexicans, the Mayas, the Peruvians, the Patagonians, and the Fuegans.

The Hon. Louis H. Morgan is the author of two very elaborate treatises on American Archæology. One, entitled Montezuma's Dinner, in the April number of the *North American Review*, aims to overthrow the florid descriptions of Mexican political organizations deduced from Spanish authorities by Prescott, Brasseur de Bourbourg, and latterly by H. H. Bancroft. The other is an attempt to reconstruct the ancient communal dwelling of the mound builders of the Mississippi Valley from the data of excavations as compared with the testimony of historians and the evidence of the modern Pueblos.

The following European journals, devoted to anthropological investigations, can receive a brief mention only. *Journal of the Anthropological Institute*, No. 15, April, 1876, contains papers on the Bhutas, on the International Symbols, on Rhabdomancy and Belomancy, on the Maories, and on Kitchen Middens in California.

Revue d'Anthropologie, 1876, No. 1, in addition to the usual amount of valuable critical matter and bibliography, contains original papers on the Gorilla, on the Brains of Idiots, on Stature, and on the Avares of Daghestan.

No. 3 of *Matériaux pour l'Histoire Primitive et Naturelle de l'Homme* is a very interesting number. The following subjects are treated: The Ossiferous Cavern of Kesserlock at Thayngen, near Schaffhausen; Sepulture of the Lacustrian Populations of Lake Neuchatel. (A short critique of this work is accompanied by full lists of tertiary diggings, quaternary diggings, surface finds, and cave finds.) Le Dictionnaire Archéologique de la Gaule. Reviews are given upon several recent anthropological treatises. The article on lacustrian sepulture is based upon the discovery of a tomb in excavating the foundation of a house near the remains of a pile-dwelling on the borders of Lake Neuchatel, between Auvernier and Columbier. The dead were inclosed in cists, several corpses in one grave interred from time to time. This sepulchre seems to have been in the transition period between the neolithic and bronze ages, because we have in the same cist rude, bronze burial deposits and uncremated bones. The further exploration of this find is expected to yield useful results.

The most interesting communication in No. 3 of *Correspondenz Blatt* is the one by Herr von Seebach, on the hitherto discovered fossil Apes and their Relation to Mankind.

Archivio per l'Antropologia, with the exception of an original memoir upon the Anthropology of Idiots, is devoted entirely to matters of special interest to Italian anthropologists. The following special treatises may be of interest to the readers of the NATURALIST: —

Zur Kentniss der Wirkung der Skoliopædie des Schädels, A. Ecker, Braunschweig, 1876. The Descriptive Catalogue of the Musical Instruments in the South Kensington Museum, C. Engel. Das Salz. Dr. M. J. Schleiden, Leipzig. The Races of Mankind and their Civilization. E. B. Tylor, before the London Institution, March 23, 1876. L'Anthropologie, P. Topinard, Paris, 1876, 1 vol. 12mo, pp. xiv., 574. Die Altesten Feurzeuge, Dr. O. Brichner, Gæa, iii., 1876.

Revue Scientifique of April 1, 1876, gives an extended account of the discovery of an ossiferous cave of the polished stone age at Belfort, near Cravanche, France. The cave belongs to the Jurassic period. The floor is covered with stalagmites, to which no stalactites correspond, and they are arranged in a certain definite order, like series of cromlechs. The bones are found in the depressions between the stalagmites encased in the calcareous matter. This discovery is especially valuable, because few sepulchres of the polished-stone age have been found as yet in Europe.

The *Journal of the Anthropological Institute* for April, 1876, in addition to articles already reported in this magazine, has a complete index of all the papers in the following publications: *Journal of the Anthropological Institute* previous to the current number; *Journal and Transactions of the Ethnological Society; Memoirs of the Anthropological Society of London.* The Smithsonian Institution is preparing a full index of all its publications, classified by subjects.

Le Compte Rendu de la Première Session du Congrés International des Américanistes, published at Paris under the editorship of Maisonneuve & Cie., comprises two octavo volumes of nearly four hundred pages each. In addition to the constitution and rules of the Société Américaine de France, the rules of the International Congress, and the list of delegates, these volumes contain nearly all the papers read at the meeting in Nancy. A wide field of discussion is covered, embracing essays upon the Phœnicians, Buddhists, Fou-Sang, the lost Atlantis, the voyages of the Northmen, and the discoveries of the fifteenth and sixteenth centuries; upon the tribal characteristics, manners, and customs, cults, migrations, and languages of the various tribes; and upon the antiquities of both continents. Although much of the discussion is speculative or even fanciful, much of it is very profitable reading, and we do not hesitate to affirm that the study of aboriginal American history was really promoted.

M. de Mainof, secretary of the ethnographical section of the Russian Geographical Society, has announced to the society that he is preparing a complete treatise on Russian Ethnography. It will appear in parts, each containing a description of one section of the people.

The April number of *Matériaux* contains a review of Italian prehistoric bibliography, for 1875; Studies on the Megalithic Monuments of the Valley of the Ouse; Superposition of the Solutréan upon the Moustieran at Thorigne (Mayenne); The Lacustrian Tombs of Auvernier, and an illustrated article by A. L. Lewis, upon the construction of Megalithic Monuments in India. Those who have sought for a rational theory of the manner in which such masses of stone were erected by uncivilized peoples in Europe, will find a plausible explanation here.

The Rhind Lectureship in Archæology, in connection with the Society of Antiquaries of Scotland, founded by a bequest of the late Alexander Henry Rhind, of Sibster, was filled during the last season by Dr. Arthur Mitchell, joint secretary of the society, upon the question, "Do we possess the means of determining scientifically the condition of primeval man and his age upon the earth?" In consequence of a great many coexistences of high and low culture in the same locality, and the immense changes known to have been wrought within the space of even a century, the author comes to the following conclusions:—

(1.) That the very rudest known form of any art may coexist in a nation with the highest.

(2.) That it would be wrong to conclude from this that the nation must be composed part of civilized and part of savage people.

(3.) That persons capable of receiving the highest culture might practice an art which belonged to the most palæolithic people. — O. T. Mason.

GEOLOGY AND PALÆONTOLOGY.

Recent Discoveries of Extinct Animals by Professor Marsh. — In a lecture to the graduating class of Yale College, delivered in the new Peabody Museum, June 3d, Professor O. C. Marsh gave a brief *résumé* of the more important results of his late palæontological researches in the Rocky Mountain region. His explorations, which were attended with much hardship and danger, have been mainly confined to the Cretaceous and Tertiary formations, and especially to the vertebrate fauna. During the past six years, the expeditions under his charge have brought to light more than three hundred species of fossil vertebrates new to science, about two hundred of which he has already described.

Among the extinct animals thus discovered, were many new groups, representing forms of life hitherto unknown. The most interesting of these are the Cretaceous *Odontornithes*, or birds with teeth, which constitute a new sub-class, containing two distinct orders, namely, the *Odontolcæ*, which have the teeth in grooves, and the *Odontotormæ*, with teeth in distinct sockets. The former were swimming birds of gigantic size, with

rudimentary wings, and the vertebræ as in modern birds. The type genus is *Hesperornis*, and three species are known. The second order embraces at present only small birds with powerful wings, and biconcave vertebræ. The type genus is *Ichthyornis*, and the geological horizon is upper Cretaceous. Another discovery of importance from the same formation was pterodactyls, or flying reptiles, the first detected in this country. These are of much interest, on account of their enormous size, — some having a spread of wings of more than twenty-five feet, — but especially as they were destitute of teeth, and hence resemble recent birds. They form a new order *Pteranodontia*, from the typical genus *Pteranodon*, six species of which are now known. With these fossils were found large numbers of Mosasauroid reptiles, and remains of more than five hundred different individuals were collected. These proved to belong to two new families, *Tylosauridæ* and *Edestosauridæ*. Some of the former attained a length of sixty feet, while the latter were much shorter, the smallest being less than ten feet. These groups included several new genera and many species. This large series of specimens enabled Professor Marsh to clear up many doubtful points in the structure of these reptiles, and to determine that they possessed hind paddles, and were covered, in part at least, with bony dermal scutes. Many other birds, reptiles, and fishes were found in the same Cretaceous strata.

The discoveries of Professor Marsh and party in the Tertiary of the West were of no less importance. The most interesting are those made in the two Eocene lake-basins between the Rocky Mountains and the Wahsatch Range. These basins were explored by Professor Marsh in 1870, and their Eocene age then first determined. His explorations in this region have secured to science over one hundred and fifty species of new vertebrates, most of them widely different from any hitherto known. The most remarkable of these are the gigantic mammals of the new order *Dinocerata*, the type genus of which is *Dinoceras*. These animals nearly equaled the elephant in size, but the limbs were shorter. The skull was armed with two or more pairs of horn-cores, and with enormous canine tusks, similar to those of the walrus. The brain was proportionally smaller than in any other land mammal. Three genera and several species are known. Remains of more than one hundred distinct individuals were obtained, and are now in the Yale Museum. The *Tillodontia* are another new order of mammals discovered in the same Eocene deposits. They possess many remarkable characters, which indicate affinities with the Carnivores, Rodents, and Ungulates. There are two well-marked families, the *Tillotheridæ*, from the typical genus *Tillotherium*, which has rodent-like incisors; and the *Stylinodontidæ*, in which all the teeth grew from persistent pulps. The largest of these peculiar animals was about the size of a tapir. One of the most interesting discoveries made by Professor Marsh in the Eocene of Wyoming was the remains of Quadrumana, the first found in the strata of America.

These early Primates appear to be related both to the lemurs of the Old World, and to some of the South American monkeys. Two families are known, the *Lemuravidæ*, from *Lemuravus*, the principal genus, which has forty-four teeth, and the *Limnotheridæ*, which have not more than forty. The latter group is rich in genera and species. Among the other Eocene mammals discovered were marsupials and bats, not before known in a fossil state in this country. One of the most important Eocene mammals found was a small ungulate, which is the oldest probable ancestor of the horse. It was about as large as a fox, and had four toes before and three behind. The genus was named *Orohippus*, and several species were discovered. These remains, in connection with others from the later tertiary, enabled Professor Marsh to trace the line of descent which has apparently produced the modern horse. In addition to the Eocene mammals, many species of birds, serpents, lizards, and other vertebrates were collected.

The discoveries made by the same expeditions in the Miocene and Pliocene lake-basins of the Rocky Mountains and Pacific coast were likewise very numerous, and many new forms of animal life were brought to light. One group of mammals found in the early Miocene of Oregon is allied to the modern *Rhinoceros*, but differs in having a transverse pair of horn-cores on the nasal bones. The genus was called *Diceratherium*, and one of its species is the oldest known member of the Rhinoceros family, if not its progenitor. The most remarkable mammals found in the Miocene were the huge *Brontotheridæ*, which are apparently allied both to the above group and to the Eocene *Dinocerata*. They equaled the latter in size, and also had an elevated pair of horn-cores on the maxillary bones. One genus of this family was previously known by a few imperfect specimens. Besides *Brontotherium*, several other new genera of this group were found, represented by portions of over two hundred individuals. With these remains was discovered a genus of small equines, *Mesohippus*, about as large as a sheep, and having three toes on each foot, with an additional "splint" bone on those in front, thus forming an interesting Miocene link in the genealogy of the horse, completed by the Pliocene genera. Over thirty species of fossil horses were collected in these formations. Among the interesting animals obtained in the Pliocene deposits were two species of large Edentates, the first tertiary representatives of this order from America. They belong to a new genus, *Morotherium*. There were also found large numbers of rhinoceroses, camels, Suillines, and other mammals, as well as many birds, reptiles, and fishes.

A study of the large series of extinct animals thus collected, and now in the Yale Museum, promises to throw much light on the development of life on this continent, and Professor Marsh has already drawn from them some important principles. One of these relates to the size and growth of the brain in mammals, from the beginning of the Tertiary to

the present time. The conclusions reached may be briefly stated as follows: *First*, all tertiary mammals had small brains; *second*, there was a gradual increase in the size of the brain during this period; *third*, this increase was mainly confined to the cerebral hemispheres, or higher portion of the brain; *fourth*, in some groups, the convolutions of the brain have gradually become more complicated; *fifth*, in some, the cerebellum and olfactory lobes have even diminished in size. There is some evidence that the same general law of brain-growth holds good for birds and reptiles from the Cretaceous to the present time.

Some additional conclusions in regard to American Tertiary mammals, so far as now known, are as follows: *First*, all the *Ungulata* from the Eocene and Miocene had upper and lower incisors; *second*, all Eocene and Miocene mammals had separate scaphoid and lunar bones; *third*, all mammals from these formations had separate metapodial bones.

In conclusion, Professor Marsh stated that his work in the field was now essentially completed, and that all the fossil remains collected, and in part described, were now in the Yale College Museum. In future, he should devote himself to their study and full description; and hoped at no distant day to make public the complete results.

Extinct Coral Reef at Bahia. — The Geological Commission of Brazil has just been examining with a great deal of interest, in the Bay of Bahia, an extinct reef, which would need little more than an intermingling with geological strata to make it resemble some of the limestone formations of the United States. Opposite the city of Bahia is the large and long island of Itaparica, which extends in nearly a northeast and southwest direction. It is formed of *cretaceous* rocks which appear along a large portion of the shore, and, outcropping underneath the water, afford good foundations for coral growth. The reef we have just mentioned is a fringing one, extending along the middle part of the southeast side of the island, for a distance of about eight nautical miles, and distant from the shore from one eighth to one quarter of a mile. It apparently follows a line of outcrop of cretaceous sandstone, and is made up mainly of a few species of corals and of nullipores, the latter form seeming to contribute the greatest amount of material to the reef. Running along the reef, we find that it varies in width from sixty to nearly two hundred feet; at extreme low tide its height above the water is about four and one half feet, and this height does not vary much throughout its entire length. At high water the reef is covered by the sea, which almost constantly breaks upon it, and, as the entire reef faces the ocean, in times of storm a heavy line of breakers is formed outside of the shore. Then, even at low tide, the sea often breaks entirely over the reef and makes an examination dangerous. There are numerous openings, or *barras*, through which small boats can enter and find a safe harbor within. At the southern end it becomes broken up and lies in detached portions. The reef has sometimes a single elevation above

low water, at other times two; where there is one, it is broad and quite level, with only slight irregularities, often broken into by pools and short channels; where there are two, the lower, which has a varying height, is broad, resembling the above, and near the outer edge it rises into a narrow upper level, very irregular and generally covered with barnacles. These two series graduate into one another. The outer edge of the reef, after rather a rapid descent from the higher levels, descends gradually under the water, but the sea has been so rough the past month as to prevent an examination far down. The inner edge is quite abrupt, descending thus to the bottom, and generally has numerous outliers. The total height of the reef above the bottom inside, is only about seven to ten feet, and often very much less from an accumulation of material there. In breaking into the upper part we always find a simple nullipore growth, layer upon layer, and so compact and hard as to often break the edge of the chisel broadly off in vain endeavors. In the lower levels we find huge heads of *Acanthastræa Braziliensis*, and more rarely *Heliastræa aperta*. *Siderastræa stellata* is abundant, and generally of large size. We also find some immense growths of *Millepora*, but even here the *Nulliporas* are the most common. The outer coating of the reef is of a brown color and all looks alike from the dead encrusting nullipores. What is the life of the reef? Only a few boring animals, now and then a specimen of *Symphyllia Harttii*, *Siderastræa stellata*, or a small *Favia* in the tide or open pools. Sea-weeds are very abundant, and there is generally a rich nullipore growth on the outer edge of the reef, for a short distance above low-tide level. We know from the raised beaches, that the shores around the bay have all been elevated at rather a late period, and the reef was undoubtedly raised at the same time. Thus the destruction of the life. It would seem as though the reef had been a coral one, but coming into the action of the waves, only nullipores could grow, and not a single coral exists in the upper portion. The bottom inside of the reef has a thick bed of fragments of the same corals we mentioned above, and in addition immense numbers of the fragments of *Mussa Harttii*, which has not yet been found alive in the bay of Bahia. This deposit is more or less consolidated, and the material composing it must have been broken from the reef during the period of its elevation. Then probably all the more fragile portions were swept inward by the waves to form this broad layer, which consists most largely of *Millepora* and *Nullipora*. The former must have been dead ere it was broken off, as the specimens are generally covered over above with a coating of *Nullipora*. — R. RATHBUN.

GEOGRAPHY AND EXPLORATION.

CAMERON'S DISCOVERIES IN AFRICA. — Lieutenant Cameron gave an account of his walk from Lake Tanganyika to the west coast of the continent, at a meeting of the Royal Geographical Society, held April 11th. He said, according to the *Geographical Magazine* for May, that most of the country from the Tanganyika to the west coast is one of almost unspeakable richness. There are metals, iron, copper, silver, and gold; coal also is found; vegetable products, palm-oil, cotton, nutmegs, several sorts of pepper and coffee, all growing wild. The people cultivate several other oil-producing plants, such as ground-nuts and *seni seni*. The Arabs, as far as they have come, have introduced rice, wheat, onions, and a few fruit-trees, all of which seem to flourish well. The countries of Bihé and Bailunda are sufficiently high above the sea to be admirably adapted for European occupation, and would produce whatever may be grown in the south of Europe. The oranges which Señor Gonsalves had planted at Bihé, where he had been settled for over thirty years, were finer than any I had ever seen in Spain or Italy. He also had roses and grapes growing in luxuriance.

The main point of the discoveries I made, I believe to be the connection of the Tanganyika with the Congo system. The Lukuga runs out of the Tanganyika, and there is no place to which it can run but to the Luvwa, which it joins at a short distance below Lake Moero. The levels I have taken prove most conclusively that it can have nothing whatever to do with the Nile; the river at Nyangwé being between 1400 and 1500 feet above the sea, while Gondokoro is over 1600 feet. And also in the dry season the flow of the Lualaba is about 126,000 cubic feet per second; that of the Ganges, which is far larger than the Nile, being not more than 80,000 cubic feet per second in flood-time, and that of the Nile at Gondokoro, below where all the streams unite, is between 40,000 and 50,000 feet per second. Many large rivers flow into the Lualaba below Nyangwé.

There is in the centre of Africa a water-system which might be utilized for commerce, which has no equal upon the face of the globe. Between the large affluents of the Congo and the head-waters of the Zambesi, a canal of between twenty and thirty miles across a level, sandy plain, would join the two systems, and the River Chambezi, which may be accepted as the head stream of the Congo, ought to be navigable to within two hundred miles of the north of Lake Nyassa. To the eastward of Lovate ivory is marvelously plentiful.

The blot upon this fair country is the continuance of the slave trade, which is carried on to a great extent, to supply those countries which have already had their population depleted by the old coast trade. The chiefs, like Kasongo and Meta Yafa, are utterly and entirely irresponsible, and would give a man leave, for the present of two or three guns, to

go and destroy as many villages, and catch as many people as he could for slaves. The Warua, especially, although holders of slaves, would rather die than be slaves themselves. I have heard instances of their being taken even as far as the Island of Zanzibar, and then making their way back, single-handed, to their own country. The only thing that will do away with slavery is opening up Africa to legitimate commerce, and this can be best done by utilizing the magnificent water-systems of the rivers of the interior.

MICROSCOPY.[1]

Wythe's Illuminator. — Dr. J. H. Wythe recommends for oblique illumination a right-angled prism with a plano-convex lens, cemented to and covering one of its narrow sides, and an ordinary French triplet fastened to the other, close to the farthest angle. Arranged with the plano-convex lens directly downward, the axis of the triplet would be horizontal, and a horizontal cone of achromatic light would be furnished; while by slightly tilting the apparatus an available and extremely oblique illumination is obtained.

San Francisco Society. — At the annual reception of this society, twenty-two members exhibited a large number of objects from the mineral, vegetable, and animal kingdoms. The intelligent classification of the views was a notable improvement upon the management of too many exhibitions of this kind.

Bliven's Photographs. — Mr. R. H. Bliven, of Elmore, Ohio, is now supplying good photographs of a large variety of objects. He also makes to order photographs of any suitable slide. Such pictures of familiar objects are very interesting. They are doubly important if the slides are particularly choice or rare, as a partial protection in case of accident to the objects themselves; while for educational purposes they are often available under circumstances where a resort to the microscope itself would cause too much interruption or delay.

Aperture of an Objective. — [Mr. Tolles contributes the following note in regard to the aperture of an objective marked 180°, which was sent to London some years ago, and has been the object of no little discussion ever since.]

The diameter of the exposed front surface of an immersion objective, is given as .043″, the point of focus as obtained by using only the rays emerging from the front, comparatively near to the axis, = .013″, and a diagram is given (Figure 25), as conclusive against any more than 118° of air-angle in the objective. But the objective was marked 180° of air-angle. A year afterwards the author of the diagram, Mr. Wenham, communicates another item relating to the angular aperture of the same lens. He gives

Fig. 25.

[1] This department is conducted by Dr. R. H. Ward, Troy, N. Y.

the greatest thickness of glass cover which it would work through as .018″, and I will supply the triangle, (Figure 26) to suit the new distance in glass.

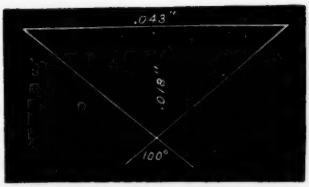

Fig. 26.

Measured by the outside lines, we have here a balsam angle of 100°. But the whole opening of the front face of an objective of quite moderate power, even, is seldom used. Accordingly, nearly a year of interval again having elapsed, he gives the utilized aperture of the front lens, front surface, as .033″. The triangle thus becomes as the dotted lines make it in (Figure 27), which I contribute to the argument. It shows 180° inevitable for a dry mount, or as closely to that incidence = 90° of obliquity as can be practically considered, and the difference between 82° and 88° clearly an increase for balsam mounts over what a dry lens can have.

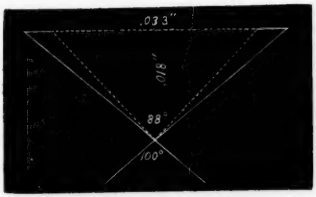

Fig. 27.

The fact is that the ray emerging into air at the extremest distance from the axis for the in-air utilized area, hugs the surface of the lens, traversing the air parallel to it. — R. B. Tolles, Boston, May 5, 1876.

Oxalate of Asparagine. — Mr. C. C. Merriman's slides are prepared from saturated solutions of asparagine and oxalic acid, and solution of gum-arabic, about in the proportions of five, four, and three parts of each respectively. The solutions are mixed only in small quantities for immediate use, and the proportion varied according to the effect produced. When dry the specimens are protected by a thin film of collodion before mounting in old balsam.

Action of Poison on Blood. — Dr. Blake found that one grain of sulphate of thorium injected into the blood vessels of a rabbit caused death in two minutes, after which the blood-corpuscles, having entirely lost their natural form, presented an indented outline with numerous highly refracting dots at the circumference.

Exchanges. — [Notices not exceeding four lines in length, of microscopical objects, or apparatus wanted or offered in exchange, not sale, will be inserted in this column without expense.]

Seeds of *Paulownia imperialis*, in exchange for other good objects. — H. S. Moore, Sixth Avenue, corner 43d Street, New York.

A large variety of objects, in exchange for any good slides. Lists furnished on application. — W. G. Corthell, 103 Warren Avenue, Boston, Mass.

Well mounted and named slides wanted in exchange for cabinet-size photographs of the objects. — R. H. Bliven, Elmore, Ohio.

SCIENTIFIC NEWS.

— Professor Henry took the opportunity at the last meeting of the National Academy of Sciences, to say a few words about the Smithsonian Institution. Its fund at present, having been increased by donations and judicious management, amounts to $717,000, although $600,000 has been expended on the building, and the original legacy produced only $541,000. Congress has enacted several liberal measures which have been of great service to the Institution and have relieved it of many expenses, such as the cost of caring for the grounds and library; and latterly an appropriation of $20,000 per year has cleared the expense of the National Museum. This liberality has enabled the Smithsonian to devote a larger share of its income toward publishing works of original research, and to defray the expense of its system of scientific exchanges, which has the whole world for its field. The publications already issued and under way were enumerated. Professor Henry said that it was contemplated to authorize a series of experiments to determine accurately the rate of increase of the earth's temperature at progressive depths. This was now rendered more practicable than before by the number of artesian wells in the country. Another project included new and careful experiments on the velocity of light; that furnishing one of the means for ascertaining the distance of the sun. Some steps had been taken to carry out this project, and a gentleman had promised to give a special fund for the purpose. The work of obtaining accurately the weight of the earth by the method devised by Cavendish would also probably be undertaken anew, there being at the present day better means for this purpose than those of the old experiments. Professor Henry alluded to his own advancing years and his anxiety to have the Smithsonian in a position of permanent security before the close of his life. The accumulations of the museum already overstock the building, and when the collections that have been sent to Philadelphia are returned, there will be no room for them. Conversing on the subject with a prominent member of Congress, he had recently stated his firm conviction that the problem could best be solved by abandoning the present building to the National Museum and erecting a new structure, to cost $100,000. The new building could be adapted solely to the needs of the Smithsonian in its proper work, and should contain besides accommodations for the system of exchange a chemical, a physical, and a biological laboratory with a lecture-room. — *N. Y. Tribune.*

— The Exeter Natural History Society was organized December 7, 1874, with the following board of officers, who still hold their positions: President, Rev. Benjamin F. McDaniel; Vice-Presidents, A. C. Perkins, Miss H. E. Paine; Secretary, William H. Gorham, M. D.; Treasurer, Charles Burley. It has a membership of between forty and fifty, and has a museum and a library, still small, but rapidly growing. Meet-

ings are held once a month, at which essays are read or topics of natural science discussed. At the society's rooms free popular lectures are given weekly. The society would be very grateful for any assistance rendered by individuals or older societies in enlarging its museum and library.

— Dr. Günther exhibited, at a late meeting of the Zoölogical Society of London, a male, female, and young specimens of a minute Australian animal (*Antechinus minutissimus*), which may be regarded as a marsupial shrew mouse; it is the smallest known Australian mammal. The female was remarkable as having seven young in the marsupium and only four mammæ.

— A number of undergraduates in the Tennessee Agricultural College of East Tennessee University, at Knoxville, have organized a science club, which meets fortnightly. The club promises to become a useful agent in diffusing an interest in the study of natural history throughout the college. At present the most popular subjects with the members of the club are entomology and botany, in both of which collections have been begun.

— Mr. Darwin is engaged upon a work on the comparative results of the cross-fertilization and self-fertilization of plants.

— The Harvard College Summer School of Geology, under the direction of Prof. N. S. Shaler, director of the Geological Survey of Kentucky, will afford geological students an opportunity of working over the area extending from the Cumberland Mountain to the Black Mountains of North Carolina, a region rich in geological, botanical, zoölogical, and archæological interest. We have received the final directions for the guidance of students of the school, which gives full details as to the expenses of the trip to Cumberland Gap, and the mode of reaching the camp. The tickets from Boston and return will be $44, the admission fee $50, including wagons, tents, and instruction. Board will be $5 a week. This is a favorable opportunity for other than geological students to travel in an inexpensive way through one of the most interesting mountain regions in the country.

— The work of the Geological Survey of Brazil is now being carried on by Professor Hartt in the interior; not being in direct communication with Rio Janeiro, letters and parcels should be sent to the secretary of the survey, Major O. C. James, Caixa no Correlo, No. 126, Rio de Janeiro, Brazil.

PROCEEDINGS OF SOCIETIES.

National Academy of Sciences. — April 18-20. Mr. L. H. Morgan began his paper entitled A Conjectural Restoration of a Pueblo of the Mound Builders, with the remark that "a conjecture is sometimes worth the time spent upon it." It is necessary first to consider

carefully some practices and usages of the aborigines which were general among them over wide areas. We find that in all parts of America they usually constructed what may be called joint-tenement houses. We find these houses occupied by a number of related families. They practiced communism in living. The marriage relation was simply pairing. They also followed certain customs, which may be designated as the law of hospitality. The land was owned in common by families and households. Those that had fully reached this method of living have been called Village Indians. Mr. Morgan thinks that the Mound Builders were probably Village Indians from New Mexico. Their arts as shown by their implements, their copper tools, their textile and fictile fabrics, were in advance of the Indian tribes found east of the Mississippi.

We find in Yucatan and Chiapas the highest type of Village Indian life. It declines as we advance northward to Mexico and New Mexico. It was best adapted to a warm climate. The attempt to transplant this mode of life from the Rio Grande or the San Juan, first to the Gulf of Mexico and then northward to the Ohio, must have been a doubtful experiment from the start. Nevertheless, the structures left by the Mound Builders indicate such an attempt; their earthworks may be regarded as the dwelling sites of Village Indians. It is certain that if a sensible use for these embankments can be discovered, the mystery about them will be dispelled. The theory that they were built for religious purposes is exceedingly improbable; the magnitude of the works, considering their grade in civilization, indicates that these Indians were laboring for themselves, not for their gods. If a tribe of Village Indians, with their acquired habits of living, emigrated to the valley of the Ohio, they would find it impossible to construct adobe houses. Some modification of the plan and character of the house would be necessary, because of the difference of climate. They might have used stone, but they did not; no stone houses had been built by these tribes. They might have made a house of inferior character upon the level ground, like the timber-framed houses of the Minnitarees. Lastly, they might have raised embankments of earth and built houses on their summits; and this, it is respectfully submitted, is what they did.

The elevated platform is a feature of the adobe houses of New Mexico; it appears also in the Yucatan dwellings. Let us regard the high bank-works on the Scioto River as a pueblo. It is an octagonal inclosure of nine hundred feet square, with an opening at each angle and in the centre of each side. The embankments are now fifty feet thick at the base, and ten or eleven feet high. If reformed with their own materials, they would produce embankments like a railway grade, thirty-seven feet wide at the base, ten feet high, and with summit platforms twenty-two feet wide. These, then, were the sites of their houses. There are six of these embankments, each four hundred and fifty feet long, and one of nine hundred feet. On the inside, before each opening, there is a

mound. If the openings were gateways defended by palisades, the whole structure became a fortress. We have now to suppose that the buildings were of timber, on the summits of the embankments, and uniform with the latter in slope. The walls of the buildings were coated with earth, and probably rose ten or twelve feet above the embankments, thus making a continuous sloping rampart twenty feet high. This form of house would harmonize with the prevailing architecture of the Village Indians; but a knowledge of the actual shape of the houses or of their interior arrangements, is not necessary to the hypothesis. The Minnitaree and Mandan Indians surround their houses with a wall of split timber, coated with earth. It may be pointed out that such structures on the edge of embankments could not be successfully assailed from without, either by Indian weapons or by fire.

Mr. Morgan exhibited a ground plan for such buildings, showing how they might have been readily constructed, and would perhaps contain from two to three hundred families, on the communal plan, and serving the purposes of their former mode of life. In fact, the mode of life necessarily determined the form of architecture. We need not discuss the uses or objects of the inclosure formed by the circular embankments. It is not improbable that it was the Village garden. But this mode of life was after all not adapted to the climate, and these emigrants eventu ally succumbed in the struggle for existence. There is evidence of the better adaptation of such a life to warmer climates, from the fact of the longer continuance of the Village Indians in Mexico, and especi lly n Central America.

Major Powell has long made Indian structures a study. He mentioned that several of his observations indicated that where tribes had made an advance in civilization, their tendency was toward the communal or pueblo form of buildings; this is indicated by the comparative age of the ruins, the most ancient not being inclosed at all, while the latest were surrounded by cliffs or walls. The age is determined chiefly by the thickness of the covering *débris*. Major Powell is inclined to believe that many of the cliff houses were built for refuge during the Spanish invasion, and such is the tradition among the Indians. Among some of the Utes the land of existence after death is placed beyond the mountains; but among the Pueblos heaven is an architectural affair; it is in the second or third story.

Professor Marsh approved the conclusions of Mr. Morgan, and brought fresh evidence to support them from an entirely different source. In a long series of comparisons of Indian skulls, Professor Marsh has been much struck by the similarity between those of the Pueblo Indians and of the Mound Builders. As the shape of the Mound Builder's skull is very peculiar, the coincidence is a very striking one. Professor Newberry added a few remarks about the buildings on the table lands, which he said were possibly six hundred or seven hundred years old, while

trees growing over the skeletons of the Mound Builders had been ingeniously shown by General Harrison to indicate an antiquity of not less than eight hundred years.

Boston Society of Natural History. — April 5th. Prof. A. Hyatt read a paper on The Relations between the Commercial Sponges of the Mediterranean and Caribbean Seas.

April 19th. Dr. B. Joy Jeffries remarked on Muscular Action associated with Vision.

SCIENTIFIC SERIALS.[1]

Monthly Microscopical Journal. — May. Note on the Markings of *Navicula rhomboides*, by J. J. Woodward. Some Results of a Microscopical Study of the Belgian Plutonic Rocks, by A. Rénard. A New Microscopic Slide, by E. Vanden Broeck. Measurements of Möller's Diatomacean Probe Platten, by E. W. Morley. — June. On the Markings of the Body-scales of the English Gnat and the American Mosquito, by J. J. Woodward. Remarks on *Frustulia saxonica*, *Navicula rhomboides*, and *N. crassinervis*, by Charles Stodder. On the Measurement of the Angular Apertures of Object-Glasses, by Jabez Hogg.

The Geographical Magazine. — May. The Arctic Expedition, vii. Prospects for the Campaign of 1876. The Island of Sokotra. Ferghana. New Maps of Mongolia.

Proceedings of the Royal Geographical Society, London. — February 23d. Lieutenant Cameron's Arrival at the West Coast of Africa. Letters detailing the Journey of the Livingstone East Coast Expedition from Lake Tanganyika to the West Coast of Africa. Stanley's Letters on his Journey to Victoria Nyanza and Circumnavigation of the Lake. Note on the Height of the Victoria Nyanza, by C. George. April 7th. Captain the Hon. G. Napier's Journey on the Turcoman Frontier of Persia, by F. Goldzmid. Extracts from Mr. Margary's Diary.

Canadian Naturalist, vol. viii., No. 2. On the Nipigon or Copper-Bearing Rocks of Lake Superior, etc., by J. W. Spencer. Notes upon the Superficial Deposits of Ontario, by D. F. H. Wilkins. New and Interesting Insects from the Carboniferous of Cape Breton, by S. H. Scudder. On the Mollusca of the Post-Pliocene Formation in Acadia, by G. F. Matthew.

The Geological Magazine. — June. The Vertical Range of Graptolites in Sweden, by G. Linnarsson. Correlation of the Graptolitic Deposits of Sweden with those of Britain, by H. A. Nicholson.

[1] The articles enumerated under this head will be for the most part selected.